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ABSTRACT

Designed for use with individualized instruction units (CE 026 345-347, and CE 026 349-351) in the REACH (Refrigeration, Electro-Mechanical, Air-Conditioning, Heating) electromechanical cluster, this first volume of the postsecondary teacher's guide is devoted to the establishment of standard instructional procedures. Following an introductory section, sections provide information in the following areas: (1) use of materials, (2) program description, (3) articulation design, (4) occupational taxonomy, (5) task listing and unit titles, (6) progress report forms, (7) organizing the laboratory, (8) text book list, (9) managing the program, and (10) student evaluation. (LRA)

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ED190841

Teacher's Guide
Volume 1
Post - Secondary Program
Management

REACH
Refrigeration
Electro-Mechanical
Air-
Conditioning
Heating

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CE 026 352

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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REFRIGERATION, HEATING AND AIR CONDITIONING

TEACHER'S GUIDE VOLUME I
PROGRAM MANAGEMENT

DEVELOPED UNDER CONTRACTUAL AGREEMENT

WITH

DIVISION OF PROGRAM DEVELOPMENT
OFFICE OF VOCATIONAL EDUCATION
GEORGIA DEPARTMENT OF EDUCATION

ATLANTA, GEORGIA 30334

CHARLES McDANIEL, STATE SUPERINTENDENT OF SCHOOLS

BY

VOCATIONAL EDUCATION TEACHERS

AND

THE UNIVERSITY OF GEORGIA STAFF

UNDER THE DIRECTION

OF

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VOCATIONAL EDUCATION MATERIALS CENTER

DIVISION OF VOCATIONAL EDUCATION

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JUNE, 1980

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Mr. Bob Corley	Georgia Earned Release Center
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Mr. Jack Dye	Coosa Valley Tech
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Lee Morris

Paul Scott

TABLE OF CONTENTS

Acknowledgements iii

Introduction 1

Use of Materials 4

Program Description 11

Articulation Design 17

Occupational Taxonomy 29

Task Listing and Unit Titles 48

Progress Report Forms 57

Organizing The Laboratory 77

Text Book List 102

Managing The Program 104

Evaluation 110

INTRODUCTION

INTRODUCTION

The delivery system and the curriculum design of the refrigeration, heating, and air conditioning curriculum can be described as a planned instructional system for individualized learning. Performance objectives have been established based on an occupational analysis of the various tasks covered by the program. Through the use of individualized instructional units based on tasks determined from the analysis, the student can progress through a planned sequence of instruction with a high degree of autonomy. The strategy of this approach is to deal with individual differences in learners through some means of relating the instruction to the needs and characteristics of the learners. By progressing at the student's own best rate of learning, subordinate skills are mastered and acceptable performances demonstrated before subsequent and more advanced tasks are attempted. The context of this guide is devoted to the establishment of standard procedures related to the operation of the refrigeration, heating, and air conditioning program. Of utmost importance to this curriculum are the processes and procedures involved in the implementation of a reliable system of planned instruction. Without the use of this method of instruction, the program is not likely to function as it was originally intended. Helpful suggestions are offered within this guide which will assist instructors in making their facility conducive to individually planned instruction, arranging resources for easy student use, and providing helpful hints for the management of the planned instructional process.

The refrigeration, heating, and air conditioning instructors and

their instructional coordinators should make note of an important point concerning these curriculum materials and their relationship to the local job market and the program. It is up to each individual school to determine what the exact content of their program should be. This is not the function of the VEMC at the University of Georgia nor is it the function of Georgia's Department of Education. At best, these groups can only suggest a curriculum which fits the general needs of the entire state. The needs of the community served by the school should dictate the actual curriculum content of the program. These needs must be carefully analyzed with the most up-to-date techniques. The most valid recommendation which can be made by the REACH curriculum developers is that a "relevance" should be established on a per unit basis to determine what else needs to be done. Some units may stand alone, others will surely require additions to meet local needs, and still others may need to be discarded from the curriculum entirely. The important point which instructors must be cognizant of if the REACH curriculum materials are to be used with successful results is that these materials are a starting point.

USE OF MATERIALS

USE OF MATERIALS

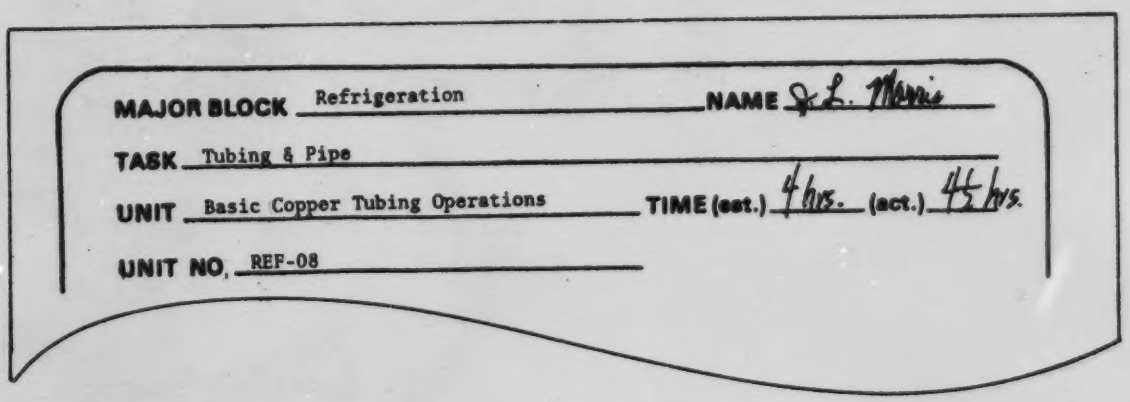
Explanation of the Unit Sheet

The learner is guided through each task by the unit sheet (also known as a flow chart). Understanding how to use the unit sheet and using it correctly is critical to the success of the program.

The unit sheet is divided into two main sections. The first or upper section lists all the information needed to identify the task and the sequence in which activities are performed. The bottom section identifies each activity.

For clarification purposes the unit sheet is displayed below in parts. The complete unit sheet is shown at the end of this section.

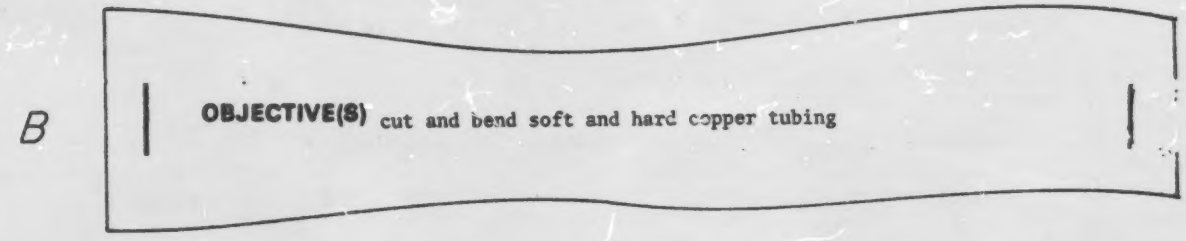
The top section of the unit sheet has three main parts. Part A specifies the Major Block that identifies the subject area being taught. The task and task number are also listed. There is a space provided for the student's name and the time spent on the task. The instructor should record the estimated time required before the student begins and then record actual time upon completion of task. If there are large deviations, the instructor should determine why and discuss it with the student.


MAJOR BLOCK Refrigeration
NAME J. L. Morris
TASK Tubing & Pipe
UNIT Basic Copper Tubing Operations
TIME (est.) 4 hrs. (act.) 4½ hrs.
UNIT NO. REF-08

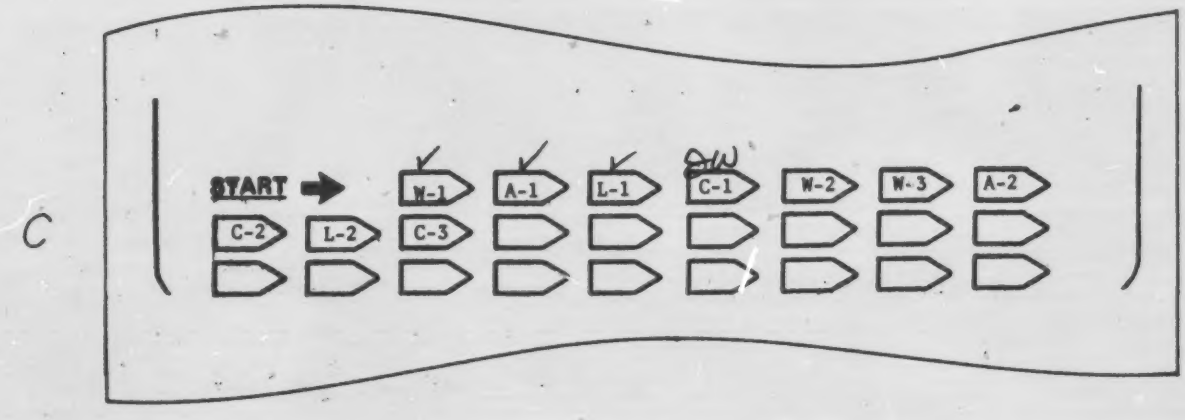
A

5

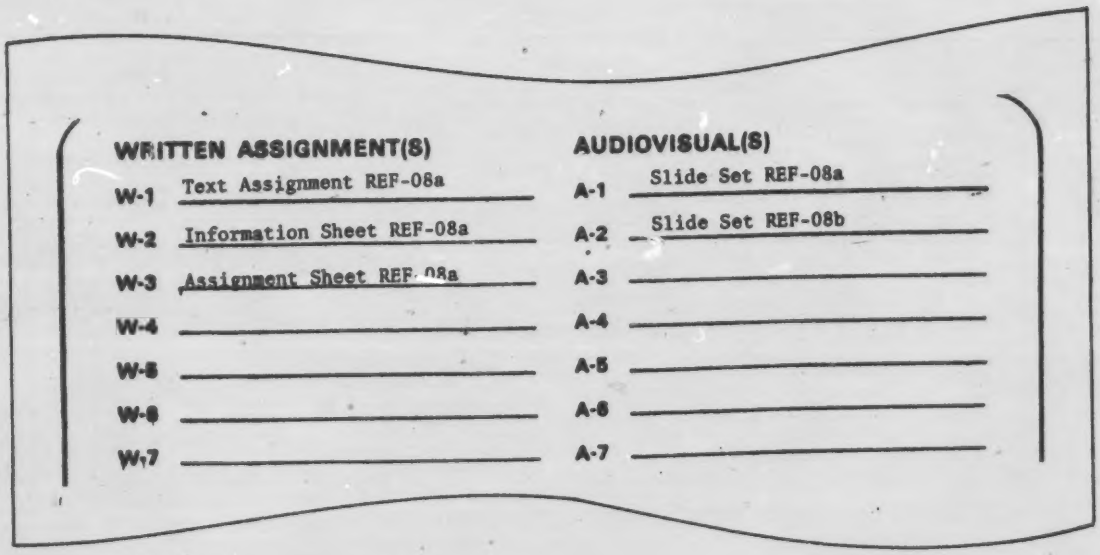
Part B contains the task objective. This should be clearly understood by the student. In some cases, the instructor may be required to further explain the objective.



Part C of the top section contains the flow chart. The chart identifies the types of activities to be performed and the sequence in which they are to be followed. Upon completion of each task, the student puts a check at the top of the arrow. For "checkpoint" arrows instructors place their own initials. This helps both the student and the instructor keep track of progress.



The bottom section of the unit sheet details the activities to be performed by the learner and the instructor. Each activity displayed in the flow chart above is identified by code number in the four separate parts of the bottom half of the unit sheet. The "Written Assignment" (W) section contains such activities as Text Assignments, Information Sheets and Assignment Sheets. The "Audio Visual" section describes which and what type A/V is used



WRITTEN ASSIGNMENT(S)		AUDIOVISUAL(S)	
W-1	Text Assignment REF-08a	A-1	Slide Set REF-08a
W-2	Information Sheet REF-08a	A-2	Slide Set REF-08b
W-3	Assignment Sheet REF-08a	A-3	
W-4		A-4	
W-5		A-5	
W-6		A-6	
W-7		A-7	

7

The "Laboratory Assignment" (L) lists the shop or "hands on" activities required for completion of this task. The "checkpoints" (C) section contains student assessment activities performed by the instructor.

LABORATORY ASSIGNMENT(S)		CHECKPOINT(S)	
L-1	Job Sheet REF-08a	C-1	Instructor Check
L-2	Job Sheet REF-08b	C-2	Instructor Check
L-3		C-3	
L-4		C-4	
L-5		C-5	
L-6		C-6	
L-7		C-7	
L-8		C-8	
L-9		C-9	

E

Using the Unit Sheet

The sample unit sheet displayed on the next page demonstrates the proper procedure for using it. The colored sections pair the flow chart information with the information in the lower section.

Colors are used for illustration purposes only and will not be used with actual student materials.

A. Instructor assigns task and writes in estimated time on task.

B. Student fills in name and reads objective.

C. Student follows flow chart beginning with W-1 (Blue)

D. Student looks at W-1 under Written Assignment section (Blue) W-1 is Text Assignment REF-08a. (The "a" at the end of the unit number denotes this as the first text assignment).

E. The student refers to the textbook list and reads the assignment. Upon completion, the student puts a checkmark above the flow chart arrow.

F. The next arrow is A-1 (Red). This corresponds to the red A-1 under the Audio Visual section.

G. The student views the first slide set (REF-08a) and places a checkmark above the arrow upon completion.

H. The next flow chart arrow in sequence is L-1 (Yellow). It corresponds to L-1 Job Sheet (REF-08a) under the Laboratory Assignments which is also yellow.

I. The student finds the job sheet in the learning package and follows the directions. Upon completion, a checkmark is put above L-1.

J. The next activity is C-1 (Green). This corresponds with C-1 in the lower section under checkpoints. Students must not go any

further until they have contacted the instructor.

K. Instructors place their initials above C-1 if satisfactory at this point. Instructors should not accept any work completed after an un-initialed checkpoint. This will discourage the student from by-passing the instructor.

L. The student continues to follow the flow chart and performing the activities specified. Upon completion of the task, the student is evaluated.

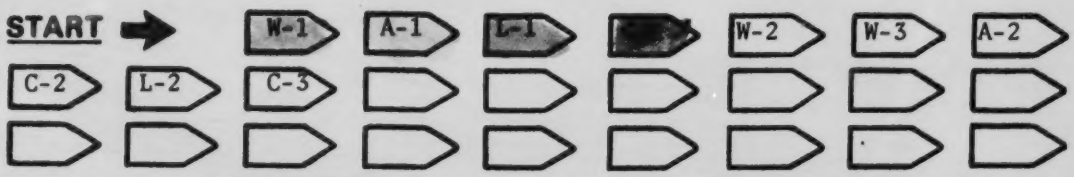
MAJOR BLOCK Refrigeration **NAME** _____

TASK Tubing & Pipe

UNIT Basic Copper Tubing Operations **TIME (est.)** _____ **(act.)** _____

UNIT NO REF-08

OBJECTIVE(S) cut and bend soft and hard copper tubing



WRITTEN ASSIGNMENT(S)

W-1 Text Assignment REF-08a
W-2 Information Sheet REF-08a
W-3 Assignment Sheet REF-08a
W-4
W-5
W-6
W-7

AUDIOVISUAL(S)

A-1 Slide Set REF-08a
A-2 Slide Set REF-08b
A-3
A-4
A-5
A-6
A-7

LABORATORY ASSIGNMENT(S)

L-1 Job Sheet REF-08a
L-2 Job Sheet REF-08b
L-3
L-4
L-5
L-6
L-7
L-8
L-9

CHECKPOINT(S)

C-1 Instructor Check
C-2 Instructor Check
C-3
C-4
C-5
C-6
C-7
C-8
C-9

PROGRAM DESCRIPTION

PROGRAM DESCRIPTION

1. Occupational Area and Scope of Instruction

The purpose of the refrigeration, heating, and air conditioning program is to teach job entry skills in occupationally related areas. Specific requirements of each of the areas (Refrigeration, Heating, or Air Conditioning or a combination of all) are based on the tasks performed by workers in "environment conditioning" occupations and held as essential for initial employment. Refrigeration, heating, and air conditioning programs in the State of Georgia offer programs which vary in length (12 months, 18 months and 24 months). The extended length of some programs allow students to specialize in commercial applications of refrigeration and in environment conditioning using solar power as an energy source.

The refrigeration, heating and air conditioning program covers tasks in the following areas: Electricity, Refrigeration, Air Conditioning and Heating. Students moving into the post-secondary program from a secondary electro-mechanical program will have covered tasks in Electricity, Refrigeration, Air Conditioning, Major Appliance Repair and Residential Electrical Wiring. As one may suspect, many tasks taught at both levels overlap to a large extent. In fact, these newly developed articulated curriculum materials use identical teaching modules in electricity, air conditioning, and refrigeration.

2. The Secondary Electro-mechanical Cluster

Secondary vocational education in Georgia has evolved into a form of multiple occupational preparation in which training for several occupations

is provided in a single laboratory. This method of grouping occupations for training purposes has been labeled as the "Cluster Concept". The cluster concept is a form of vocational training which prepares the student for gainful employment in a number of occupations, all requiring similar types of skills and knowledges. The primary concern of the cluster is to prepare graduates for initial employment through the attainment of job entry skills. Exposure to the several related occupations in the clusters is likely to provide greater mobility across occupational lines and will avoid locking youth into a single occupation because of specialized training in only one skill.

3. Planned Instruction

Tasks and objectives of each occupational area have been clearly defined. Students may easily determine from the curriculum which skills must be mastered and the number of interim objectives which must be completed before program objectives have been reached. Once implemented, the planned process of instruction will direct the student through the various activities required to master the various tasks. Students are directed to the specific audio-visual or other resource needed to complete the task. Activities are also provided to give the students hands-on training. The instruction refers the student to the instructor for purposes of evaluation, status checks or safety precautions which are coordinated with specific sections in the teachers' guide.

In implementing this planned curriculum, the instruction serves three major functions. It determines,

1. <u>What is to be learned</u>. It identifies objectives to be completed which will fulfill the requirement of the curriculum.

2. How objectives will be reached. It provides a description of projects utilized and a specification of the types of activities on which training objectives will be reached.
3. When objectives have been satisfied. It establishes the criteria to be utilized in measuring the mastery of the various skills.

4. Job or Project Oriented

It is the ultimate desire of the refrigeration, heating, and air conditioning curriculum to provide training at the post-secondary level which will provide graduates with entry level skills for initial employment in environment conditioning occupations. For this reason it is important to maintain conditions in the instructional programs as closely related to those expected and required in the industry. The following guidelines will aid in assuring that standards are maintained at an acceptable level and that activities are in line with those expected by the industry.

A. Safe practices are suggested throughout the curriculum. The entire electrical industry is required by law to meet minimum standards of safety. All of these safety standards should therefore be used in the laboratory.
B. Federal, state and local codes have been established for virtually every phase of the industry. These codes are especially important to the student since the ultimate goal is eventual placement within the workforce. Codes must be available to students and their use required on all jobs and

projects. Good safe work habits can be instilled in conjunction with workmanship, self-discipline and punctuality.

C. It is especially important for training projects to be closely identified with jobs in the industry. The isolated nature of instructional areas from the actual job requires that training projects be simulated as closely as possible to realistic conditions. This can usually be done in any phase of the program without violating realistic specifications, electrical codes, safety practices or other such standards which might affect health or the quality of work.

D. Standards of performance on all projects and jobs should be in line with those expected in industry. Student attitudes toward work habits and quality workmanship can be affected by high expectations from instructors and the rejection of less than acceptable performances on training projects.

5. Ease of Revision

The instructional units of this program are designed in such a way that changes may be easily made. Substitutions for difficult to obtain or out of date references or textbooks can be made on the text assignment sheet by inserting the desired changes into a "Master Copy" of the student manual.

Occasionally tasks or jobs change because of technological developments. If tasks become outdated, they may be deleted from the instructional sequence by removing the undesirable units from the program.

Additionally, new tasks or activities may be added without seriously affecting the continuity or flow of the instruction. The coding system of the instructional units provide added flexibility in making changes to the master copy. Requiring students to make changes from the master copy prior to beginning each module corrects student manuals and

saves valuable instructor time.

The individualized units in this program are designed to allow ease of revision. Instructors should not hesitate to make changes that reflect standards or practices due to geographical locations and climatic conditions common to specific regions. Instructors are encouraged to make changes which would better suit the needs of specific programs.

ARTICULATION DESIGN

This section of the Teacher's Guide will describe the articulation design which prevailed throughout the REACH curriculum development project. The rationale for articulation between the secondary electro-mechanical program and the post-secondary refrigeration, heating, and air conditioning program is presented.

The primary concern of the cluster is to prepare graduates for initial employment through the attainment of job entry skills. In addition, it should provide the basic skills and knowledge which would enable the student to continue training for a selected occupation at a post-secondary institution. Furthermore, for the delivery system to function properly, the skills mastered at the secondary level should be assessed and recognized at the receiving post secondary institution.

The full intention of the cluster is to provide two initial years of instruction in all areas of the program while gradually increasing emphasis in one area. The third year of planned instruction should provide indepth or advanced training in an area of the students choice. Upon graduation the student may gain employment in the selected field or continue training at the post secondary level. If any correlation exists between the amount of training received and the level at which entry is made into the occupation it could then be expected that a student completing a cluster program and seeking the post secondary level would increase his or her chances of successful employment and would probably permit the student to enter the occupation at a higher level.

The electro-mechanical cluster can be a beginning point for several occupational areas. The major blocks of study within the electro-mechanical cluster are,

1. Electricity
2. Residential Wiring
3. Major Appliance Repair
4. Refrigeration

A student who studies within the confines of the secondary electro-mechanical program could, with an adequate articulation process, move quite easily into any of these post secondary programs:

1. Refrigeration
2. Heating and Air Conditioning
3. Major Appliances Repair
4. Industrial Electricity

At this point it should be noted that even though in the development of the REACH (Refrigeration, Electro-mechanical, Air Conditioning and Heating) curriculum a post-secondary refrigeration, heating and air conditioning section has been a major thrust; in theory, articulation between it and the secondary electro-mechanical program should be no more significant than articulation with any other related post-secondary programs.

The Task Articulation Schedule in the next section lists all of the units available in the secondary electro-mechanical curriculum. In addition, the five post-secondary programs are listed across the top of the page. In the vertical columns an indication is made as to whether the secondary unit is related to a particular post secondary program. In some instances (such as EL-01 through EL-09) a single unit may have a direct relationship to all five programs. In other instances (such as MA-19) it may only relate to one. In

all cases, however, there are units taught in a post secondary school (within the four areas) that are directly related, if not identical to each of the units taught in the secondary electro-mechanical program.

In order to prevent unnecessary duplication in the overlap between the sending secondary electro-mechanical programs and the post secondary receiving programs an articulation process is necessary. A key element in this process is the identification of tasks taught on both levels, the coordination of curriculum development between both the secondary and post secondary vocational programs, and a highly structured transfer of credit procedure.

X indicates the task taught in the secondary electro-mechanical column is also taught in the post-secondary program indicated.

TASK ARTICULATION SCHEDULE

SECONDARY	POST SECONDARY				
Electro Mechanical	Heating and Air Conditioning	Industrial Electricity	Radio and Television	Electronics	Major Appliance Repair
EL-01 Understanding basic electrical theory	X	X	X	X	X
EL-02 Computing Ohm's Law and power formulas	X	X	X	X	X
EL-03 Using electric meters	X	X	X	X	X
EL-04 Identifying series and parallel circuits	X	X	X	X	X
EL-05 Understanding solid state fundamentals	X	X	X	X	X
EL-06 Identifying electrical symbols	X	X	X	X	X
EL-07 Reading a basic schematic diagram	X	X	X	X	X
EL-09 Understanding alternating current principles	X	X	X	X	X
EL-10 Determining, selecting wire size and making connections	X	X			X
EL-11 Making necessary connections to main panel (breaker and fused) to supply service to air conditioners	X	X			X
EL-12 Servicing shaded pole motors	X	X			X
EL-13 Wiring split phase motors	X	X			X
EL-14 Checking capacitors	X	X			X
EL-15 Hooking up and troubleshooting a PSC (capacitor run) motor	X	X			X
EL-16 Hooking up and troubleshooting a CS motor	X	X			X
EL-17 Hooking up and troubleshooting a CSR motor	X	X			X
EL-18 Hooking up a three phase motor	X	X			X
EL-19 Testing motors	X	X			X

TASK ARTICULATION SCHEDULE

SECONDARY	POST SECONDARY				
Electro Mechanical	Heating and Air Conditioning	Industrial Electricity	Radio and Television	Electronics	Major Appliance Repair
EL-20 Maintenance of electric motors	X	X			X
EL-21 Installing and testing a transformer	X	X			X
EL-22 Installing and testing contacts and relays	X	X			X
EL-23 Installing and checking thermostats	X	X			X
REF-02 Identifying career opportunities in Refrigeration, Heating and Air Conditioning	X				X
REF-03 Understanding basic refrigeration concepts	X				X
REF-04 Understanding the basic refrigeration cycle	X				X
REF-05 Identifying tools	X				X
REF-06 Tapping, threading, and replacing threads	X				X
REF-07 Fitting nomenclature and pipe materials	X				X
REF-08 Basic copper tubing operations	X				X
REF-09 Soft soldering copper tubing	X				X
REF-10 Silver brazing	X				X
REF-11 Handling refrigerants	X				X
REF-12 Using access valves	X				X
REF-13 Maintaining refrigeration manifold gauges	X				X
REF-14 Installing and using refrigeration manifold gauges	X				X
REF-15 Using a vacuum pump	X				X
REF-16 Installing refrigeration accessories	X				X
REF-17 Testing for leaks	X				X

TASK ARTICULATION SCHEDULE

SECONDARY	POST SECONDARY				
Electro Mechanical	Heating and Air Conditioning	Industrial Electricity	Radio and Television	Electronics	Major Appliance Repair
REF-18 Charging the system	X				X
REF-19 Testing the compressor	X				X
REF-20 Applying principles of condensor	X				X
REF-21 Applying principles and uses of the evaporator	X				X
REF-22 Troubleshooting an automatic expansion valve	X				X
REF-23 Applying principles of troubleshooting capillary tubes	X				X
REF-24 Troubleshooting thermostatic expansion valve	X				X
REF-25 Troubleshooting the refrigeration system	X				X
REF-26 Installation of a window unit	X				X
REF-27 Performing pre-season start up for window A/C	X				X
REF-28 Troubleshooting compressor burn out in a window A/C	X				X
REF-29 Evacuating and charging a window A/C unit	X				X
REF-30 Troubleshooting fans and fan motors	X				X
REF-31 Troubleshooting window air conditioner's (refrigeration cycle)	X				X
REF-32 Troubleshooting window air conditioner electrical system	X				X
REF-33 Understanding basic operations of a refrigerator or freezer	X				X

TASK ARTICULATION SCHEDULE

SECONDARY	POST SECONDARY				
Electro Mechanical	Heating and Air Conditioning	Industrial Electricity	Radio and Television	Electronics	Major Appliance Repair
REW-14 Designing circuits		X			
REW-15 Estimating materials		X			
MA-01 Installing electric ranges					X
MA-02 Installing electric oven					X
MA-03 Installing surface unit and hood					X
MA-04 Installing automatic electric dryers					X
MA-05 Installing washing machine					X
MA-06 Installing dishwasher					X
MA-07 Installing hot water heater					X
MA-08 Installing refrigerator and freezer					X
MA-09 Transporting major appliances					X
MA-10 Checking and replacing hoses					X
MA-11 Checking and replacing belts					X
MA-12 Testing and installing drive and timer motor					X
MA-13 Testing and installing overload protector and capacitors					X
MA-14 Testing and replacing solenoids					X
MA-15 Servicing drain pumps					X
MA-16 Testing and replacing water level control					X
MA-17 Replacing belts and idler pullys					X
MA-18 Checking and repairing blower assembly					X

TASK ARTICULATION SCHEDULE

SECONDARY	POST SECONDARY				
Electro Mechanical	Heating and Air Conditioning	Industrial Electricity	Radio and Television	Electronics	Major Appliance Repair
MA-19 Testing and replacing heating elements					X
MA-20 Test and repairing dryer electrical system					X
MA-21 Replacing a dryer motor					X
MA-22 Testing and replacing solenoid					X
MA-23 Testing and replacing safety door switch					X
MA-24 Checking and replacing heating element on dishwasher					X
MA-25 Testing and replacing motor relay					X
MA-26 Replacing automatic dispenser					X
MA-27 Testing and replacing drain pump					X
MA-28 Testing and installing timer					X
MA-29 Diagnosing and repairing automatic dishwasher					X
MA-30 Testing and replacing heating elements					X
MA-31 Testing and replacing thermostat control					X
MA-32 Installing and setting pressure relief system					X
MA-33 Testing and replacing surface unit elements					X
MA-34 Testing and replacing surface unit switches					X
MA-35 Testing and replacing oven elements					X
MA-36 Testing and replacing oven temperature controls					X

TASK ARTICULATION SCHEDULE

SECONDARY	POST SECONDARY				
Electro Mechanical	Heating and Air Conditioning	Industrial Electricity	Radio and Television	Electronics	Major Appliance Repair
REF-34 Evacuating and charging refrigerators and freezers	X				X
REF-35 Troubleshooting refrigerators and freezers (refrigeration cycle)	X				X
REF-36 Troubleshooting fans and fan motors	X				X
REF-37 Troubleshooting compressor burnout on refrigerators and freezers	X				X
REF-38 Troubleshooting refrigerators and freezers (electrical cycle)	X				X
REW-01 Installing 115v appliances outlets		X			
REW-02 Installing convenience outlets		X			
REW-03 Installing lighting outlet		X			
REW-04 Installing split and switched receptacles		X			
REW-05 Installing a door bell circuit		X			
REW-06 Installing a three-way switch		X			
REW-07 Installing a 230v circuits and outlets		X			
REW-08 Installing meter base, mast or entrance cable and weatherhead		X			
REW-09 Install main panel		X			
REW-10 Installing grounding system		X			
REW-11 Installing temporary service		X			
REW-12 Using standard measurement	X	X			
REW-13 Identifying residential wiring symbols		X			

TASK ARTICULATION SCHEDULE

SECONDARY	POST SECONDARY				
Electro Mechanical	Heating and Air Conditioning	Industrial Electricity	Radio and Television	Electronics	Major Appliance Repair
MA-37 Replacing automatic timers					X
MA-38 Service continuous cleaning and self cleaning ovens					X
RT-01 Checking and replacing power cords			**	**	
RT-02 Checking and replacing vacuum tubes			**	**	
RT-03 Checking and replacing diodes			**	**	
RT-04 Checking and replacing transistors			**	**	
RT-05 Checking and replacing voltage multipliers			**	**	
RT-06 Checking and replacing integrated circuits			**	**	
RT-07 Checking and replacing resistors			**	**	
RT-08 Checking and replacing capacitors			**	**	
RT-09 Checking and replacing transformers			**	**	
RT-10 Checking and replacing circuit protective devices			**	**	
RT-11 Checking and replacing speakers and headsets			**	**	
RT-12 Servicing couplings			**	**	
RT-13 Servicing amplifiers			**	**	
RT-14 Servicing oscillators			**	**	
RT-15 Servicing power supply circuits			**	**	
RT-16 Servicing audio/output circuits			**	**	
RT-17 Servicing detector/AVC circuits			**	**	
RT-18 Servicing IF circuits			**	**	

** These are supplementary units which are not included in the REACH curriculum. They are, however, taught in many Electro-Mechanical programs.

TASK ARTICULATION SCHEDULE

SECONDARY	POST SECONDARY				
Electro Mechanical	Heating and Air Conditioning	Industrial Electricity	Radio and Television	Electronics	Major Appliance Repair
RT-19 Servicing converter circuits					
RT-20 Servicing RF circuits			**	**	
RT-21 Servicing operator controls and information components			**	**	
RT-22 Servicing high-voltage power supply circuits			**	**	
RT-23 Servicing picture tube yokes			**		
RT-24 Servicing video/detector circuits			**		
RT-25 Servicing SYHC circuits			**		
RT-26 Servicing vertical sweep circuits			**		
RT-27 Servicing horizontal sweep circuits			**		
RT-28 Servicing picture tubes			**		
RT-29 Servicing RF tuners			**		
RT-30 Servicing color IF circuits			**		
RT-31 Servicing color killer circuits			**		

OCCUPATIONAL TAXONOMY

It is important at both secondary and post secondary levels of vocational education to establish long and short range goals. This suggests that students entering an occupational training program would expect upon completion to be eligible for employment in that field. As in most industrial fields, there is a range of occupations for which employment can be attained. Some require highly specialized training while others require minimal time and training in a vocational program.

A vocational program should be flexible enough to accomodate students seeking either of these goals. Further, various reasons exist as to why flexible goals should be provided to students. These include entering late in a secondary program, disadvantaged students, handicapped students or others not physically or mentally capable of mastering a highly specialized skill.

One major purpose of the electro-mechanical cluster and the refrigeration, heating, and air conditioning program is to train students for several occupations related to electricity and refrigeration. The relative nature of occupations trained for in either the secondary or post-secondary program suggests that many of the tasks are the same or similar. Therefore, it may be assumed that once the skill or task has been mastered it is transferable from one occupational area to another and from high school to post high school programs which are similar.

The short and long range goals have been identified in order to give some physical substance to the jobs which the student can perform upon completion of such training. The occupational classifications should depict

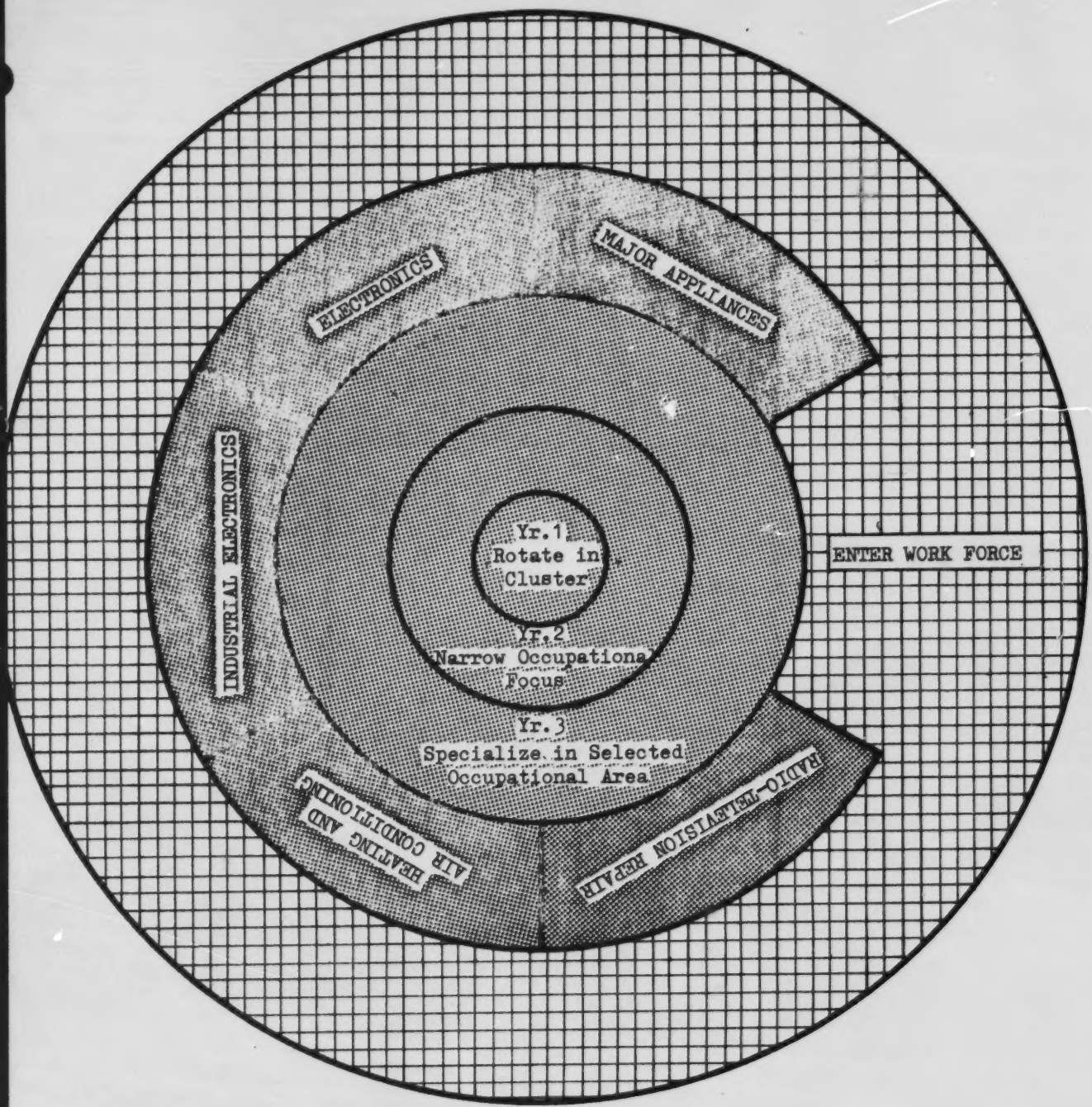
some hierarchial form of the industry depending almost entirely on the amount of training received. It is important to note that a different or a more highly specialized occupation will be formed when two or more of the classifications are combined. Following is a listing of these occupations and the tasks to be accomplished under each. In reviewing these listings one should realize that the occupations do not necessarily form the sequence of instruction in the training program. The sequence of instruction will differ with each program depending on the type and level of training. (In addition, the reader should note that these listings are designed as examples of occupations covered by the REACH curriculum materials and their corresponding tasks).

Selected Occupational Taxonomy for
Electro-Mechanical Programs and for
Refrigeration, Heating, and Air Conditioning

1. Refrigeration and Major Appliance Technician
2. Major Appliance Technician
3. Major Appliance Installer
4. Window Air Conditioning Service Technician
5. Window Air Conditioner Installer
6. House Electrician
7. Electrician's Helper
8. Domestic Environmental Control Technician
9. Furnace Installer/Repairer (Domestic)
10. Air Conditioner Installer/Servicer (Domestic)

The occupational Training Alternatives Model on the next page illustrates some of the possible paths a student may take while in the electro-mechanical cluster and upon completion (including movement into the post-secondary refrigeration, heating, and air conditioning program).

OCCUPATIONAL TRAINING
ALTERNATIVES MODEL



— SECONDARY

— POST SECONDARY

— ENTER WORK FORCE

1. Refrigeration and Major Appliance Technician

MA-01 Installing electric ranges
MA-02 Installing electric oven
MA-03 Installing surface unit and hood
MA-04 Installing automatic electric dryers
MA-05 Installing washing machine
MA-06 Installing dishwasher
MA-07 Installing hot water heater
MA-08 Installing refrigerator and freezer
MA-09 Transporting major appliances
MA-10 Total washing machine operation
MA-11 Electrical systems operation and troubleshooting
MA-12 Testing and installing capacitors
MA-13 Mechanical systems operation and troubleshooting
MA-14 Checking and replacing belts
MA-15 Water systems operation and troubleshooting
MA-16 Replacing belts and idler pullys
MA-17 Checking and repairing blower assembly
MA-18 Testing and replacing heating elements
MA-19 Testing and repairing dryer electrical system
MA-20 Replacing a dryer motor
MA-21 Testing and replacing solenoid
MA-22 Checking water level control and testing and replacing safety door swi
MA-23 Checking and replacing heating element on dishwasher
MA-24 Testing and replacing motor relay
MA-25 Replacing automatic dispenser
MA-26 Testing and replacing drain pump
MA-27 Testing and installing timer
MA-28 Diagnosing and repairing automatic dishwasher
MA-29 Testing and replacing heating elements
MA-30 Testing and replacing thermostat control
MA-31 Installing and setting pressure relief valve
MA-32 Testing and replacing surface unit elements
MA-33 Testing and replacing surface unit switches
MA-34 Testing and replacing oven elements
MA-35 Testing and replacing oven temperature controls
MA-36 Replacing automatic timers
MA-37 Service continuous cleaning and self cleaning ovens

EL-01 Understanding basic electrical theory
EL-02 Computing Ohm's Law and power formulas
EL-03 Using electric meters
EL-04 Identifying series and parallel circuits
EL-05 Understanding solid state fundamentals
EL-06 Identifying electrical symbols
EL-07 Reading a basic schematic diagram
EL-08 Reading an advanced schematic diagram
EL-09 Understanding alternating current principles
EL-10 Determining, selecting wire size and making connections
EL-11 Making necessary connections to main panel (breaker and fused) to supply service to air conditioners
EL-12 Servicing shaded pole motors
EL-13 Wiring split phase motors
EL-14 Checking capacitors
EL-15 Hooking up and troubleshooting a PSC (capacitor run) motor

i. Refrigeration and Major Appliance Technician (CONTINUED)

EL-16 Hooking up and troubleshooting a CS motor
EL-17 Hooking up and troubleshooting a CSR motor
EL-18 Hooking up a three phase motor
EL-19 Testing motors
EL-20 Maintenance of electric motors
EL-21 Installing and testing a transformer
EL-22 Installing and testing contacts and relays
EL-23 Installing and checking thermostats

REF-02 Identifying safe working conditions
REF-03 Understanding basic refrigeration concepts
REF-04 Understanding the basic refrigeration cycle
REF-05 Identifying tools
REF-06 Tapping, threading, and replacing threads
REF-07 Fitting nomenclature and pipe materials
REF-08 Basic copper tubing operations
REF-09 Soft soldering copper tubing
REF-10 Silver brazing
REF-11 Handling refrigerants
REF-12 Using access valves
REF-13 Maintaining refrigeration manifold gauges
REF-14 Installing and using refrigeration manifold gauges
REF-15 Using a vacuum pump
REF-16 Installing refrigeration accessories
REF-17 Testing for leaks
REF-18 Charging the system
REF-19 Testing the compressor
REF-20 Applying principles of condensor
REF-21 Applying principles and uses of the evaporator
REF-22 Troubleshooting an automatic expansion valve
REF-23 Applying principles of troubleshooting capillary tubes
REF-24 Troubleshooting thermostatic expansion valve
REF-25 Troubleshooting the refrigeration system
REF-26 Installation of a window unit
REF-27 Performing pre-season start up for window A/C
REF-28 Troubleshooting compressor burn out in a window A/C
REF-29 Evacuating and charging a window A/C unit
REF-30 Troubleshooting fans and fan motors
REF-31 Troubleshooting window air conditioner's (refrigeration cycle)
REF-32 Troubleshooting window air conditioner electric system
REF-33 Understanding basic operations of a refrigerator or freezer
REF-34 Evacuating and charging refrigerators and freezers
REF-35 Troubleshooting refrigerators and freezers (refrigeration cycle)
REF-36 Troubleshooting fans and fan motors
REF-37 Troubleshooting compressor burnout on refrigerators and freezers
REF-38 Troubleshooting refrigerators and freezers (electrical cycle)

REW-01 Installing 115v appliances outlets
REW-02 Installing convenience outlets
REW-03 Installing lighting outlet
REW-04 Installing split and switched receptacles
REW-05 Installing a door bell circuit
REW-06 Installing a three-way circuit
REW-07 Installing a 230v circuits and outlets

2. Major Appliance Technician

MA-01 Installing electric ranges
MA-02 Installing electric oven
MA-03 Installing surface unit and hood
MA-04 Installing automatic electric dryers
MA-05 Installing washing machine
MA-06 Installing diswasher
MA-07 Installing hot water heater
MA-08 Installing refrigerator and freezer
MA-09 Transporting major appliances
MA-10 Total washing machine operation
MA-11 Electrical systems operation and troubleshooting
MA-12 Testing and installing capacitors
MA-13 Mechanical systems operation and troubleshooting
MA-14 Checking and replacing belts
MA-15 Water systems operation and troubleshooting
MA-16 Replacing belts and idler pullys
MA-17 Checking and repairing blower assembly
MA-18 Testing and replacing heating elements
MA-19 Testing and repairing dryer electrical system
MA-20 Replacing a dryer motor
MA-21 Testing and replacing solenoid
MA-22 Checking water level control and testing and replacing safety door sw
MA-23 Checking and replacing heating element on dishwasher
MA-24 Testing and replacing motor relay
MA-25 Replacing automatic dispenser
MA-26 Testing and replacing drain pump
MA-27 Testing and installing timer
MA-28 Diagnosing and repairing automatic dishwasher
MA-29 Testing and replacing heating elements
MA-30 Testing and replacing thermostat control
MA-31 Installing and setting pressure relief valve
MA-32 Testing and replacing surface unit elements

EL-01 Understanding basic electrical theory
EL-02 Computing Ohm's Law and power formulas
EL-03 Using electric meters
EL-04 Identifying series and parallel circuits
EL-05 Understanding solid state fundamentals
EL-06 Identifying electrical symbols
EL-07 Reading a basic schematic diagram
EL-08 Reading an advanced schematic diagram
EL-09 Understanding alternating current principles
EL-10 Determining, selecting wire size and making connections
EL-11 Making necessary connections to main panel (breaker and fused) to supply service to air conditioners

REW-01 Installing 115v appliances outlets
REW-02 Installing convenience outlets
REW-03 Installing lighting outlet
REW-04 Installing split and switched receptacles
REW-05 Installing a door bell circuit
REW-06 Installing a three-way circuit
REW-07 Installing a 230v circuits and outlets

5. Major Appliance Installer

MA-01 Installing electric ranges
MA-02 Installing electric oven
MA-03 Installing surface unit and hood
MA-04 Installing automatic electric dryers
MA-05 Installing washing machine
MA-06 Installing dishwasher
MA-07 Installing hot water heater
MA-08 Installing refrigerator and freezer
MA-09 Transporting major appliances

EL-01 Understanding basic electrical theory
EL-02 Computing Ohm's Law and power formulas
EL-03 Using electric meters
EL-04 Identifying series and parallel circuits
EL-05 Understanding solid state fundamentals
EL-06 Identifying electrical symbols
EL-07 Reading a basic schematic diagram
EL-08 Reading an advanced schematic diagram
EL-09 Understanding alternating current principles
EL-10 Determining, selecting wire size and making connections
EL-11 Making necessary connections to main panel (breaker and fused) to supply service to air conditioners

REW-01 Installing 115v appliances outlets
REW-02 Installing convenience outlets
REW-03 Installing lighting outlet
REW-04 Installing split and switched receptacles
REW-05 Installing a door bell circuit
REW-06 Installing a three way circuit
REW-07 Installing a 230v circuit and outlet

4. Window Air Conditioner Service Technician

AC-06 Installation of a window unit
AC-07 Performing pre-season start up for window A/C
AC-08 Troubleshooting compressor burn out in a window A/C
AC-09 Evacuating and charging a window A/C unit
AC-10 Troubleshooting fans and fan motors
AC-11 Troubleshooting window air conditioners (refrigeration cycle)
AC-12 Troubleshooting window air conditioner electric system

EL-01 Understanding basic electrical theory
EL-02 Computing Ohm's Law and power formulas
EL-03 Using electric meters
EL-04 Identifying series and parallel circuits
EL-05 Understanding solid state fundamentals
EL-06 Identifying electric symbols
EL-07 Reading a basic schematic diagram
EL-09 Understanding alternating current principles
EL-10 Determining, selecting wire size and making connections
EL-11 Making necessary connections to main panel (breaker and fused) to supply service to air conditioners
EL-12 Servicing shaded pole meters
EL-13 Wiring split phase motors
EL-14 Checking capacitors
EL-15 Hooking up and troubleshooting a PSC (capacitor run) motor
EL-16 Hooking up and troubleshooting a CS motor
EL-17 Hooking up and troubleshooting a CSR motor
EL-18 Hooking up a three phase motor
EL-19 Testing motors
EL-20 Maintenance of electric motors
EL-21 Installing and testing a transformer
EL-22 Installing and testing contacts and relays
EL-23 Installing and checking thermostats

5. Window Air Conditioner Installer

REF-26 Installation of a window unit

EL-01 Understanding basic electrical theory
EL-02 Computing Ohm's Law and power formulas
EL-03 Using electric meters
EL-04 Identifying series and parallel circuits
EL-05 Understanding solid state fundamentals
EL-06 Identifying electrical symbols
EL-07 Reading a basic schematic diagram
EL-08 Reading an advanced schematic diagram
EL-09 Understanding alternating current principles
EL-10 Determining, selecting wire size and making connections
EL-11 Making necessary connections to main panel (breaker and fused) to supply service to air conditioners

REW-01 Installing 115v appliances outlets
REW-02 Installing convenience outlets
REW-03 Installing lighting outlet
REW-04 Installing split and switched receptacles
REW-05 Installing a door bell circuit
REW-06 Installing a three-way circuit
REW-07 Installing a 230v circuits and outlets

6. House Electrician

EL-01 Understanding basic electrical theory
EL-02 Computing Ohm's Law and power formulas
EL-03 Using electric meters
EL-04 Identifying series and parallel circuits
EL-09 Understanding alternating current principles
EL-10 Determining, selecting wire size and making connections
EL-11 Making necessary connections to main panel (breaker and fused) to supply service to air conditioners

REW-01 Installing 115v appliances outlets
REW-02 Installing convenience outlets
REW-03 Installing lighting outlet
REW-04 Installing split and switched receptacles
REW-05 Installing a door bell circuit
REW-06 Installing a three-way circuit
REW-07 Installing a 230v circuits and outlets
REW-08 Installing a meter base, mast or entrance cable and weatherhead
REW-09 Install main panel
REW-10 Installing grounding system
REW-11 Installing temporary service
REW-12 Using standard measurement
REW-13 Identifying residential wiring symbols
REW-14 Designing circuits
REW-15 Estimating materials

7. Electricians Helper

REW-01 Installing 115v appliances outlets
REW-02 Installing convenience outlets
REW-03 Installing lighting outlet
REW-04 Installing split and switched receptacles
REW-05 Installing a door bell circuit
REW-06 Installing a three-way circuit
REW-07 Installing a 230v circuits and outlets
REW-08 Installing a meter base, mast or entrance cable and weatherhead
REW-09 Install main panel
REW-10 Installing grounding system
REW-11 Installing temporary service
REW-12 Using standard measurement
REW-13 Identifying residential wiring symbols

8. Domestic Environmental Control Technician

AC-01 Understanding air conditioning systems
AC-02 Applying basic air principles
AC-03 Calculating heat loads
AC-04 Understanding air movement
AC-05 Identifying air filtering systems
AC-06 Installation of a window unit
AC-07 Performing pre-season start up for window A/C
AC-08 Troubleshooting compressor burn out in a window A/C
AC-09 Evacuating and charging a window A/C unit
AC-10 Troubleshooting fans and fan motors
AC-11 Troubleshooting window air conditioner's (refrigeration cycle)
AC-12 Troubleshooting window air conditioner electric system
AC-13 Install condensate drain
AC-14 Installing package unit (residential and mobile home)
AC-15 Installing split system
AC-16 Installing add-on split system
AC-17 Troubleshooting compressor burnout
AC-18 Troubleshooting fans and fan motors
AC-19 Performing pre-season start up
AC-20 Troubleshooting air conditioner's (refrigeration cycle)
AC-21 Troubleshooting air conditioner's (electrical cycle)
AC-22 Troubleshooting air conditioner's (air movement)
AC-23 Understanding principles of the heat pump
AC-24 Evacuating and charging the heat pump
AC-25 Installing reversing valve (refrigeration cycle)
AC-26 Refrigeration cycle and components
AC-27 Installing electrical circuits
AC-28 Adjusting and repairing defrost controls
AC-29 Designing supplementary heat systems
AC-30 Installing package heat pump
AC-31 Installing split system
AC-32 Troubleshooting heat pump

HE-01 Understanding principles of electric furnaces and controls
HE-02 Installing electric furnaces
HE-03 Troubleshooting electric furnaces
HE-04 Applying gas fuel combustion and safety principles
HE-05 Understanding basic systems (types of furnaces)
HE-06 Checking gas sources
HE-07 Gas piping principles
HE-08 Adjusting regulators
HE-09 Installing and servicing gas valves
HE-10 Installing and servicing pilot ignition devices
HE-11 Installing and servicing combination gas valves
HE-12 Servicing burners
HE-13 Inspecting and determining temperature rise of heat exchanges
HE-14 Venting heat system
HE-15 Servicing electrical controls
HE-16 Determining combustion efficiency
HE-17 Performing pre-season checkup and start up

8. Domestic Environmental Control Technician (CONTINUED)

HE-18 Troubleshooting the heating system
HE-19 Identifying types of fuel oil and principles of combustion
HE-20 Designing and installing oil piping
HE-21 Installing oil burners
HE-22 Installing and servicing transformers and electrodes
HE-23 Installing oil pumps
HE-24 Servicing blower, nozzle, motor and coupling
HE-25 Installing vent and heat exchanger
HE-26 Installing controls
HE-27 Performing pre-season start up and check up
HE-28 Troubleshooting the oil burning heating system
HE-29 Installing humidifier

EL-01 Understanding basic electrical theory
EL-02 Computing Ohm's Law and power formulas
EL-03 Using electric meters
EL-04 Identifying series and parallel circuits
EL-05 Understanding solid state fundamentals
EL-06 Identifying electric symbols
EL-07 Reading a basic schematic diagram
EL-08 Reading an advanced schematic diagram
EL-09 Understanding alternating current principles
EL-10 Determining, selecting wire size and making connections
EL-11 Making necessary connections to main panel (breaker and fused) to supply service to air conditioners
EL-12 Servicing shaded pole meters
EL-13 Wiring split phase motors
EL-14 Checking capacitors
EL-15 Hooking up and troubleshooting a PSC (capacitor run) motor
EL-16 Hooking up and troubleshooting a CS motor
EL-17 Hooking up and troubleshooting a CSR motor
EL-18 Hooking up a three phase motor
EL-19 Testing motors
EL-20 Maintenance of electric motors
EL-21 Installing and testing a transformer
EL-22 Installing and testing contacts and relays
EL-23 Installing and checking thermostats
EL-24 Installing and checking pressure switches
EL-25 Troubleshooting an overload
EL-26 Installing and checking miscellaneous controls
EL-27 Troubleshooting magnetic starters
EL-28 Wiring packaged air conditioners
EL-29 Wiring split system air conditioner
EL-30 Designing control panel
EL-31 Designing advanced control panel
EL-32 Troubleshooting electrical control system (basic)
EL-33 Troubleshooting electrical control system (advanced)

REF-01 Identifying career opportunities in Refrigeration, Heating and A/C
REF-02 Identifying safe working conditions
REF-03 Understanding basic refrigeration concepts
REF-04 Understanding the basic refrigeration cycle

8. Domestic Environmental Control Technician (CONTINUED)

REF-05 Identifying tools
REF-06 Tapping, threading, and replacing threads
REF-07 Fitting nomenclature and pipe materials
REF-08 Basic copper tubing operations
REF-09 Soft soldering copper tubing
REF-10 Silver brazing
REF-11 Handling refrigerants
REF-12 Using access valves
REF-13 Maintaining refrigeration manifold gauges
REF-14 Installing and using refrigeration manifold gauges
REF-15 Using a vacuum pump
REF-16 Installing refrigeration accessories
REF-17 Testing for leaks
REF-18 Charging the system
REF-19 Testing the compressor
REF-20 Applying principles of condensor
REF-21 Applying principles and uses of the evaporator
REF-22 Troubleshooting an automatic expansion valve
REF-23 Applying principles of troubleshooting capillary tubes
REF-24 Troubleshooting thermostatic expansion valve
REF-25 Troubleshooting the refrigeration system
REF-26 Installation of a window unit
REF-27 Performing pre-season start up for window A/C
REF-28 Troubleshooting compressor burn out in a window A/C
REF-29 Evacuating and charging a window A/C unit
REF-30 Troubleshooting fans and fan motors
REF-31 Troubleshooting window air conditioner's (refrigeration cycle)
REF-32 Troubleshooting window air conditioner electric system

9. Furnace Installer/Repairer (Domestic)

HE-01 Understanding principles of electric furnaces and controls
HE-02 Installing electric furnaces
HE-03 Troubleshooting electric furnaces
HE-04 Applying gas fuel combustion and safety principles
HE-05 Understanding basic systems (types of furnaces)
HE-06 Checking gas sources
HE-07 Gas piping principles
HE-08 Adjusting regulators
HE-09 Installing and servicing gas valves
HE-10 Installing and servicing pilot ignition devices
HE-11 Installing and servicing combination gas valves
HE-12 Servicing burners
HE-13 Inspecting and determining temperature rise of heat exchanges
HE-14 Venting heat system
HE-15 Servicing heat system
HE-16 Determining combustion efficiency
HE-17 Performing pre-season checkup and start up
HE-18 Troubleshooting the heating system
HE-19 Identifying types of fuel oil and principles of combustion
HE-20 Designing and installing oil piping
HE-21 Installing oil burners
HE-22 Installing and servicing transformers and electrodes
HE-23 Installing oil pumps
HE-24 Servicing blower, nozzle, motor and coupling
HE-25 Installing vent and heat exchanger
HE-26 Installing controls
HE-27 Performing pre-season unit start up and check up
HE-28 Troubleshooting the oil burning heating system
HE-29 Installing humidifier

EL-01 Understanding basic electrical theory
EL-02 Computing Ohm's Law and power formulas
EL-03 Using electric meters
EL-04 Identifying series and parallel circuits
EL-05 Understanding solid state fundamentals
EL-06 Identifying electric symbols
EL-07 Reading a basic schematic diagram
EL-08 Reading an advanced schematic diagram
EL-09 Understanding alternating current principles
EL-10 Determining, selecting wire size and making connections
EL-11 Making necessary connections to main panel (breaker and fused) to supply service to air conditioners
EL-12 Servicing shaded pole meters
EL-13 Wiring split phase motors
EL-14 Checking capacitors
EL-15 Hooking up and troubleshooting a PSC (capacitor run) motor
EL-16 Hooking up and troubleshooting a CS motor
EL-17 Hooking up and troubleshooting a CSR motor
EL-18 Hooping up a three phase motor
EL-19 Testing motors
EL-20 Maintenance of electric motors
EL-21 Installing and testing a transformer

9. Furnace Installer/Repairer (Domestic) (CONTINUED)

EL-22 Installing and testing contacts and relays
EL-23 Installing and checking thermostats
EL-24 Installing and checking pressure switches
EL-25 Troubleshooting an overload
EL-26 Installing and checking miscellaneous controls
EL-27 Troubleshooting magnetic starters
EL-28 Wiring packaged air conditioners
EL-29 Wiring split system air conditioner
EL-30 Designing control panel
EL-31 Designing advanced control panel
EL-32 Troubleshooting electrical control system (basic)
EL-33 Troubleshooting electrical control system (advanced)

10. Air Conditioner Installer/Servicer (Domestic)

AC-01 Understanding air conditioning systems
AC-02 Applying basic air principles
AC-03 Calculating heat loads
AC-04 Understanding air movement
AC-05 Identifying air filtering systems
AC-06 Installation of a window unit
AC-07 Performing pre-season start up for window A/C
AC-08 Troubleshooting compressor burn out in a window A/C
AC-09 Evacuating and charging a window A/C unit
AC-10 Troubleshooting fans and fan motors
AC-11 Troubleshooting window air conditioner's (refrigeration cycle)
AC-12 Troubleshooting window air conditioner electric system
AC-13 Install condensate drain
AC-14 Installing package unit (residential and mobile home)
AC-15 Installing split system
AC-16 Installing add-on split system
AC-17 Troubleshooting compressor burnout
AC-18 Troubleshooting fans and fan motors
AC-19 Performing pre-season start up
AC-20 Troubleshooting air conditioner's (refrigeration cycle)
AC-21 Troubleshooting air conditioner's (electricial cycle)
AC-22 Troubleshooting air conditioner's (air movement)
AC-23 Understanding principles of the heat pump
AC-24 Evacuating and charging the heat pump
AC-25 Installing reversing valve (refrigeration cycle)
AC-26 Refrigeration cycle and components
AC-27 Installing electrical circuits
AC-28 Adjusting and repairing defrost controls
AC-29 Designing supplementary heat systems
AC-30 Installing package heat pump
AC-31 Installing split system
AC-32 Troubleshooting heat pump

EL-01 Understanding basic electrical theory
EL-02 Computing Ohm's Law and power formulas
EL-03 Using electric meters
EL-04 Identifying series and parallel circuits
EL-05 Understanding solid state fundamentals
EL-06 Identifying electric symbols
EL-07 Reading a basic schematic diagram
EL-08 Reading an advanced schematic diagram
EL-09 Understanding alternating current principles
EL-10 Determining, selecting wire size and making connections
EL-11 Making necessary connections to main panel (breaker and fused) to supply service to air conditioners
EL-12 Servicing shaded pole meters
EL-13 Wiring split phase motors
EL-14 Checking capacitors
EL-15 Hooking up and troubleshooting a PSC (capacitor run) motor
EL-16 Hooking up and troubleshooting a CS motor
EL-17 Hooking up and troubleshooting a CSR motor
EL-18 Hooking up a three phase motor

10. Air Conditioner Installer/Servicer (Domestic) (CONTINUED)

EL-19 Testing motors
EL-20 Maintenance of electric motors
EL-21 Installing and testing a transformer
EL-22 Installing and testing contacts and relays
EL-23 Installing and checking thermostats
EL-24 Installing and checking pressure switches
EL-25 Troubleshooting an overload
EL-26 Installing and checking miscellaneous controls
EL-27 Troubleshooting magnetic starters
EL-28 Wiring packaged air conditioners
EL-29 Wiring split system air conditioner
EL-30 Designing control panel
EL-31 Designing advanced control panel
EL-32 Troubleshooting electrical control system (basic)
El-33 Troubleshooting electrical control system (advanced)

TASK LISTING AND UNIT TITLES

ELECTRICITY

I. Fundamentals

- EL-01 Understanding basic electrical theory
- EL-02 Computing Ohm's Law and power formulas
- EL-03 Using electric meters
- EL-04 Identifying series and parallel circuits
- EL-05 Identifying electrical symbols
- EL-06 Reading a basic schematic diagram
- EL-07 Reading an advanced schematic diagram
- EL-08 Understanding alternating current principles
- EL-09 Determining, selecting wire size and making connections
- EL-10 Making main panel connections to air conditioners

II. Electric Motors

- EL-11 Servicing shaded pole motors
- EL-12 Wiring split phase motors
- EL-13 Checking capacitors
- EL-14 Hooking up and troubleshooting a PSC (capacitor run) motor
- EL-15 Hooking up and troubleshooting a CS motor
- EL-16 Hooking up and troubleshooting a CSR motor
- EL-17 Hooking up a three phase motor
- EL-18 Testing motors
- EL-19 Maintenance of electric motors

ELECTRICITY (continued)

III. Electrical Components

EL-20. Installing and testing a transformer

EL-21. Installing and testing contacts and relays

EL-22. Installing and checking thermostats

EL-23. Installing and checking pressure switches

EL-24. Troubleshooting an overload

EL-25. Installing and checking miscellaneous controls

EL-26. Troubleshooting magnetic starters

IV. Controls and Installation

EL-27. Wiring packaged air conditioners

EL-28. Wiring split system air conditioner

EL-29. Designing control panel

EL-30. Designing advanced control panel

EL-31. Troubleshooting electrical control system (basic)

EL-32. Troubleshooting electrical control system (advanced)

EL-33. Servicing solid-state control circuits

REFRIGERATION

1. Refrigeration Fundamentals

REF-01 Identifying career opportunities in Refrigeration, Heating and Air Conditioning

REF-02 Identifying safe working conditions

REF-03 Understanding basic refrigeration concepts

REF-04 Understanding the basic refrigeration cycle

REF-05 Identifying tools

REF-06 Tapping, threading, and replacing threads

REF-07 Fitting nonenclosure and pipe materials

II. Tubing and Pipe

REF-08 Basic copper tubing operations

REF-09 Soft soldering copper tubing

REF-10 Silver brazing

III. Refrigerants

REF-11 Handling refrigerants

REF-12 Using access valves

REF-13 Maintaining refrigeration manifold gauges

REF-14 Installing and using refrigeration manifold gauges

REF-15 Using a vacuum pump

REF-16 Installing refrigeration accessories

REF-17 Testing for leaks

REF-18 Charging the system

REFRIGERATION (continued)

IV. Troubleshooting

REF-19 Testing the compressor

REF-20 Applying principles of condenser

REF-21 Applying principles and uses of the evaporator

REF-22 Troubleshooting an automatic expansion valve

REF-23 Applying principles of troubleshooting capillary tubes

REF-24 Troubleshooting thermostatic expansion valve

REF-25 Troubleshooting the refrigeration system

AIR CONDITIONING

1. Air conditioning Fundamentals

AC-01 Demonstrate a knowledge of air conditioning systems

AC-02 Applying basic air principles

AC-03 Calculating heat loads

AC-04 Applying principles of air movement

AC-05 Identifying air filtering systems

II. Window Air Conditioning

AC-06 Installation of a window unit

AC-07 Performing pre-season start up for window A/C

AC-08 Troubleshooting compressor burnout in a window A/C

AC-09 Evacuating and charging a window A/C unit

AC-10 Troubleshooting fans and fan motors

AC-11 Troubleshooting window air conditioner's (refrigeration cycle)

AC-12 Troubleshooting window air conditioner electric system

III. System and Installation

AC-13 Install condensate drain

AC-14 Installing package unit (residential and mobile home)

AC-15 Installing split system

AC-16 Installing add-on split system

AIR CONDITIONING (continued)

IV. Troubleshooting and servicing

AC-17 Troubleshooting compressor burnout

AC-18 Troubleshooting fans and fan motors

AC-19 Performing pre-season start up

AC-20 Troubleshooting air conditioner's (refrigeration cycle)

AC-21 Troubleshooting air conditioner's (electrical cycle)

AC-22 Troubleshooting air conditioner's (air movement)

V. Heat Pump

AC-23 Understanding principles of the heat pump

AC-24 Evacuating and charging the heat pump

AC-25 Installing reversing valve (refrigeration cycle)

AC-26 Refrigeration cycle and components

AC-27 Installing electrical circuits

AC-28 Adjusting and repairing defrost controls

AC-29 Designing supplementary heat systems

AC-30 Installing package heat pump

AC-31 Installing split system

AC-32 Troubleshooting heat pump

HEATING

I. Electric Heating Systems

HE-01 Demonstrate a knowledge of the principles of electric furnaces and controls

HE-02 Installing electric furnaces

HE-03 Troubleshooting electric furnaces

II. Gas Heating Systems

HE-04 Applying gas fuel combustion and safety principles

HE-05 Understanding basic systems (types of furnaces)

HE-06 Checking gas sources

HE-07 Gas piping principles

HE-08 Adjusting regulators

HE-09 Installing and servicing gas valves

HE-10 Installing and servicing pilot ignition devices

HE-11 Installing and servicing combination gas valves

HE-12 Servicing burners

HE-13 Inspecting and determining temperature rise of heat exchangers

HE-14 Venting heat system

HE-15 Servicing electrical controls

HE-16 Determining combustion efficiency

HE-17 Performing pre-season checkup and start up

HE-18 Troubleshooting the heating system

HEATING (continued)

III. Oil Burning Systems

HE-19 Identifying types of fuel oil and principles of combustion

HE-20 Designing and installing oil piping

HE-21 Installing oil burners

HE-22 Installing and servicing transformers and electrodes

HE-23 Installing oil pumps

HE-24 Servicing blower, nozzle, motor and coupling

HE-25 Recognizing types of heat exchangers and performing the combustion test

HE-26 Installing controls

HE-27 Performing pre-season start up and checkup

HE-28 Troubleshooting the oil burning heating system

HE-29 Installing and servicing humidifiers

PROGRESS REPORT FORMS

STUDENT PERFORMANCE RECORDS

As an aid to making articulation between secondary and post-secondary programs in the state a reality, a Student Performance Record has been developed. This record should be reproduced by the teacher, then filled in and kept up to date by the teacher. A copy of the record can be kept as a part of the student's permanent record at the school and copies may be sent to potential employers and to post-secondary schools to show what the student studied while in the electro-mechanical cluster.

Instructors using the Student Performance Record should make note of two things concerning the Record. First, the Record is written in a coded form. An additional document will be needed by employers to interpret it. Instructors in both the secondary school and the post secondary school will have copies of this teachers' guide and can use it to determine that EL-05 is "Identifying electrical symbols", etc. This information may be obtained in the Task Listing and Unit Titles section or in this Progress Report Forms section. The second point to be noted is that the record has spaces for a rating at the secondary level and at the post secondary level. The record may start at the comprehensive high school and follow the student to the area vocational school then to permanent employment.

GEORGIA VOCATIONAL EDUCATION STUDENT PERFORMANCE RECORD

ELECTRO—MECHANICAL/REFRIGERATION,HEATING and AIR CONDITIONING

Student Name _____ Social Security Number _____

Schools _____ Dates _____ Instructor(s) _____

_____ _____ _____

_____ _____ _____

Rating	Level of Performance
1	Degree of skill below minimum performance level
2	Acceptable level of skill; can perform with supervision and/or assistance
3	High level of skill; can perform independently and consistently at a high level

The rating on this performance record gives the entry level vocational skills this student has demonstrated based on set standards or criteria. This record is intended for use in assessing the student's ability for employment or advanced educational purposes. An item left unmarked indicates the student has not received instruction.

The first blank indicates the secondary rating - the second blank is the post secondary rating.

MAJOR BLOCK -- Electricity (EL)

PERFORMANCE GROUP -- Fundamentals

EL-01 _ _	EL-02 _ _	EL-03 _ _
EL-04 _ _	EL-05 _ _	EL-06 _ _
EL-07 _ _	EL-08 _ _	EL-09 _ _
EL-10 _ _	EL-11 _ _	

PERFORMANCE GROUP -- Electric Motors

EL-12 _ _	EL-13 _ _	EL-14 _ _
EL-15 _ _	EL-16 _ _	EL-17 _ _
EL-18 _ _	EL-19 _ _	EL-20 _ _

PERFORMANCE GROUP -- Electrical Components

EL-21 _ _	EL-22 _ _	EL-23 _ _
EL-24 _ _	EL-25 _ _	EL-26 _ _
EL-27 _ _		

PERFORMANCE GROUP -- Controls and Installation

EL-28 _ _	EL-29 _ _	EL-30 _ _
EL-31 _ _	EL-32 _ _	EL-33 _ _

MAJOR BLOCK -- Refrigeration (REF)

PERFORMANCE GROUP -- Refrigeration Fundamentals

REF-01 _ _	REF-02 _ _	REF-03 _ _
REF-04 _ _	REF-05 _ _	REF-06 _ _
REF-07 _ _		

PERFORMANCE GROUP -- Tubing and Pipe

REF-08 _ _	REF-09 _ _	REF-10 _ _

PERFORMANCE GROUP -- Refrigerants

REF-11 _ _	REF-12 _ _	REF-13 _ _
REF-14 _ _	REF-15 _ _	REF-16 _ _
REF-17 _ _	REF-18 _ _	

PERFORMANCE GROUP -- Troubleshooting

REF-19 _ _	REF-20 _ _	REF-21 _ _
REF-22 _ _	REF-23 _ _	REF-24 _ _
REF-25 _ _		

PERFORMANCE GROUP -- Window Air Conditioning

REF-26 (AC-06) _ _	REF-27 (AC-07) _ _	
REF-28 (AC-08) _ _	REF-29 (AC-09) _ _	
REF-30 (AC-10) _ _	REF-31)AC-11) _ _	
REF-32 (AC-12) _ _		

PERFORMANCE GROUP -- Refrigerators and Freezers

REF-33 _ _	REF-34 _ _	REF-35 _ _
REF-36 _ _	REF-37 _ _	REF-38 _ _

MAJOR BLOCK - - Residential Wiring (REW)

PERFORMANCE GROUP -- Grounded Outlets

REW-01 _ _	REW-02 _ _	REW-03 _ _
REW-04 _ _	REW-05 _ _	REW-06 _ _
REW-07 _ _		

PERFORMANCE GROUP -- Service Entrance

REW-08 _ _	REW-09 _ _	REW-10 _ _

PERFORMANCE GROUP -- Blueprint Reading

REW-11 _ _	REW-12 _ _	REW-16 _ _
REW-14 _ _		

MAJOR BLOCK -- Major Appliance (MA)

PERFORMANCE GROUP -- Installation of Appliances

MA-01 _ _	MA-02 _ _	MA-03 _ _
MA-04 _ _	MA-05 _ _	MA-06 _ _
MA-07 _ _	MA-08 _ _	MA-09 _ _

PERFORMANCE GROUP -- Troubleshooting Washing Machines

MA-10 _ _ MA-11 _ _ MA-12 _ _
MA-13 _ _ MA-14 _ _ MA-15 _ _

PERFORMANCE GROUP - - Troubleshooting Electric Dryer

MA-16 _ _ MA-17 _ _

PERFORMANCE GROUP -- Troubleshooting Automatic Dishwasher

MA-18 _ _ MA-19 _ _ MA-20 _ _
MA-21 _ _ MA-22 _ _ MA-23 _ _
MA-24 _ _ MA-25 _ _

PERFORMANCE GROUP -- Troubleshooting Electric Range

MA-26 _ _ MA-27 _ _ MA-28 _ _
MA-29 _ _ MA-30 _ _ MA-31 _ _

MAJOR BLOCK -- Radio/Television (RT) .

PERFORMANCE GROUP -- Identifying, Testing, and Replacing Component Parts

RT-01 _ _ RT-02 _ _ RT-03 _ _
RT-04 _ _ RT-05 _ _ RT-06 _ _
RT-07 _ _ RT-08 _ _ RT-09 _ _
RT-10 _ _ RT-11 _ _

PERFORMANCE GROUP -- Testing and Repairing Radio/Television Circuits

RT-12 _ _ RT-13 _ _ RT-14 _ _
RT-15 _ _ RT-16 _ _ RT-17 _ _
RT-18 _ _ RT-19 _ _ RT-20 _ _
RT-21 _ _

PERFORMANCE GROUP -- Testing and Repairing Television Circuits

RT-22 _ _ RT-23 _ _ RT-24 _ _
RT-25 _ _ RT-26 _ _ RT-27 _ _
RT-28 _ _ RT-29 _ _

PERFORMANCE GROUP -- Testing and Repairing Color TV Circuits

RT-30 _ _ RT-31 _ _ RT-32 _ _
RT-33 _ _ RT-34 _ _

MAJOR BLOCK -- Air Conditioning (AC)

PERFORMANCE GROUP--Air Conditioning Fundamentals

AC-01 _ _ AC-02 _ _ AC-03 _ _
AC-04 _ _ AC-05 _ _

PERFORMANCE GROUP -- System and Installation

AC-13 _ _ AC-14 _ _ AC-15 _ _
AC-16 _ _

PERFORMANCE GROUP--Troubleshooting and Servicing

AC-17 _ _ AC-18 _ _ AC-19 _ _
AC-20 _ _ AC-21 _ _ AC-22 _ _

PERFORMANCE GROUP -- Heat Pump

AC-23 _ _ AC-24 _ _ AC-25 _ _
AC-26 _ _ AC-27 _ _ AC-28 _ _
AC-29 _ _ AC-30 _ _ AC-31 _ _
AC-32 _ _

MAJOR BLOCK -- Heating (HE)

PERFORMANCE GROUP -- Electric Heating Systems

HE-01 _ _ HE-02 _ _ HE-03 _ _

PERFORMANCE GROUP -- Gas Heating Systems

HE-04 _ _ HE-05 _ _ HE-06 _ _
HE-07 _ _ HE-08 _ _ HE-09 _ _
HE-10 _ _ HE-11 _ _ HE-12 _ _
HE-13 _ _ HE-14 _ _ HE-15 _ _
HE-16 _ _ HE-17 _ _ HE-18 _ _

PERFORMANCE GROUP -- Oil Burning Systems

HE-19 _ _ HE-20 _ _ HE-21 _ _
HE-22 _ _ HE-23 _ _ HE-24 _ _
HE-25 _ _ HE-26 _ _ HE-27 _ _
HE-28 _ _ HE-29 _ _

Other Tasks -- Comments

INDIVIDUAL PROGRESS REPORT

NAME _____

PROGRAM Refrigeration, Heating, and Air Conditioning AREA Electricity

UNIT NO.	UNIT TITLE	DATE STARTED	DATE COMP.	EST. TIME	GRADE
	FUNDAMENTALS				
EL-01	Understanding basic electrical theory				
EL-02	Computing OHm's Law and power formulas				
EL-03	Using electric meters				
EL-04	Identifying series and parallel circuits				
EL-05	Identifying electrical symbols				
EL-06	Reading a basic schematic diagram				
EL-07	Reading an advanced schematic diagram				
EL-08	Understanding alternating current				
	principles				
EL-09	Determining, selecting wire size and				
	making connections				
EL-10	Making main panel connectionns to air				
	conditioners				
	ELECTRIC MOTORS				
EL-11	Servicing shaded pole motors				
EL-12	Wiring split phase motors				
EL-13	Checking capacitors				
EL-14	Hooking up and troubleshooting a PSC				
	(capacitor run) motor				
EL-15	Hooking up and troubleshooting a CS				
	motor				
EL-16	Hooking up and troubleshooting a CSR				
	motor				
EL-17	Hooking up a three phase motor				
EL-18	Testing motors				
EL-19	Maintenance of electric motors				

INDIVIDUAL PROGRESS REPORT

NAME _____

PROGRAM Refrigeration, Heating, and Air Conditioning AREA Electricity

UNIT NO.	UNIT TITLE	DATE STARTED	DATE COMP.	EST. TIME	GRADE
	ELECTRICAL COMPONENTS				
EL-20	Installing and testing a transformer				
EL-21	Installing and testing contacts and				
	relays				
EL-22	Installing and checking thermostats				
EL-23	Installing and checking pressure				
	switches				
EL-24	Troubleshooting an overload				
EL-25	Installing and checking miscellaneous				
	controls				
EL-26	Troubleshooting magnetic starters				
	CONTROLS AND INSTALLATION				
EL-27	Wiring packaged air conditioners				
EL-28	Wiring split system air conditioner				
EL-29	Designing control panel				
EL-30	Designing advanced control panel				
EL-31	Troubleshooting electrical control				
	system (basic)				
EL-32	Troubleshooting electrical control				
	system (advanced)				
EL-33	Servicing solid-state control circuits				

INDIVIDUAL PROGRESS REPORT

NAME _____

PROGRAM Refrigeration, Heating, and Air Conditioning AREA Refrigeration

UNIT NO.	UNIT TITLE	DATE STARTED	DATE COMP.	EST. TIME	GRADE
	REFRIGERATION FUNDAMENTALS				
REF-01	Identifying career opportunities in Refrigeration, Heating, and Air Conditioning				
REF-02	Identifying safe working conditions				
REF-03	Understanding basic refrigeration concepts				
REF-04	Understanding the basic refrigeration cycle				
REF-05	Identifying tools				
REF-06	Tapping, threading, and replacing threads				
REF-07	Fitting nomenclature and pipe materials				
REF-08					
	TUBING AND PIPE				
REF-08	Basic copper tubing operations				
REF-09	Soft soldering copper tubing				
REF-10	Silver Brazing				
	REFRIGERANTS				
REF-11	Handling refrigerants				
REF-12	Using access valves				
REF-13	Maintaining refrigeration manifold gauges				
REF-14	Installing and using refrigeration manifold gauges				
REF-15	Using a vacuum pump				
REF-16	Installing refrigeration accessories				
REF-17	Testing for leaks				
REF-18	Charging the system				

INDIVIDUAL PROGRESS REPORT

NAME_____

PROGRAM Refrigeration, Heating, and Air Conditioning AREA Refrigeration

UNIT NO.	UNIT TITLE	DATE STARTED	DATE COMP.	EST. TIME	GRADE
REF-19	Testing the compressor				
REF-20	Applying principles of condensor				
REF-21	Applying principles and uses of the				
	evaporator				
REF-22	Troubleshooting an automatic expansion				
	valve				
REF-23	Applying principles of troubleshooting				
	capillary tubes .				
REF-24	Troubleshooting thermostatic expansion				
	valve				
REF-25	Troubleshooting the refrigeration system				

INDIVIDUAL PROGRESS REPORT

NAME_____

PROGRAM Refrigeration, Heating, and Air Conditioning AREA Air Conditioning

UNIT NO.	UNIT TITLE	DATE STARTED	DATE COMP.	EST. TIME	GRADE
	AIR CONDITIONING FUNDAMENTALS				
AC-01	Demonstrate a knowledge of air conditioning systems				
AC-02	Applying basic air principles				
AC-03	Calculating heat loads				
AC-04	Applying principles of air movement				
AC-05	Identifying air filtering systems				
	WINDOW AIR CONDITIONING				
AC-06	Installation of a window unit				
AC-07	Performing pre-season start up for window A/C				
AC-08	Troubleshooting compressor burnout in a window A/C				
AC-09	Evacuating and charging a window A/C unit				
AC-10	Troubleshooting fans and fan motors				
AC-11	Troubleshooting window air conditioner's (refrigeration cycle)				
AC-12	Troubleshooting window air conditioner electric system				
	SYSTEM AND INSTALLATION				
AC-13	Install condensate drain				
AC-14	Installing package unit (residential and mobile home)				
AC-15	Installing split system				
AC-16	Installing add-on split system				

INDIVIDUAL PROGRESS REPORT

NAME _____

PROGRAM Refrigeration, Heating, and Air Conditioning AREA Air Conditioning

UNIT NO.	UNIT TITLE	DATE STARTED	DATE COMP.	EST. TIME	GRADE
	TROUBLESHOOTING AND SERVICING				
AC-17	Troubleshooting compressor burnout				
AC-18	Troubleshooting fans and fan motors				
AC-19	Performing pre-season start up				
AC-20	Troubleshooting air conditioner's (refrigeration cycle)				
AC-21	Troubleshooting air conditioner's (electrical cycle).				
AC-22	Troubleshooting air conditioner's (air movement)				
	HEAT PUMP				
AC-23	Understanding principles of the heat pump				
AC-24	Evacuating and charging the heat pump				
AC-25	Installing reversing valve (refrigeration cycle)				
AC-26	Refrigeration cycle and components				
AC-27	Installing electrical circuits				
AC-28	Adjusting and repairing defrost controls				
AC-29	Designing supplementary heat systems				
AC-30	Installing package heat pump				
AC-31	Installing split system				
AC-32	Troubleshooting heat pump				

INDIVIDUAL PROGRESS REPORT

NAME _____

PROGRAM Refrigeration, Heating, and Air Conditioning AREA Heating

UNIT NO.	UNIT TITLE	DATE STARTED	DATE COMP.	EST. TIME	GRADE
	ELECTRIC HEATING SYSTEMS				
HE-01	Demonstrate a knowledge of the principles				
	of electric furnaces and controls				
HE-02	Installing electric furnaces				
HE-03	Troubleshooting electric furnaces				
	GAS HEATING SYSTEMS				
HE-04	Applying gas fuel combustion and safety				
	principles				
HE-05	Understanding basic systems (types of				
	furnaces)				
HE-06	Checking gas sources				
HE-07	Gas piping principles				
HE-08	Adjusting regulators				
HE-09	Installing and servicing gas valves				
HE-10	Installing and servicing pilot ignition				
	devices				
HE-11	Installing and servicing combination gas				
	valves				
HE-12	Servicing burners				
HE-13	Inspecting and determining temperature				
	rise of heat exchangers				
HE-14	Venting heat system				
HE-15	Servicing electrical controls				
HE-16	Determining combustion efficiency				
HE-17	Performing pre-season checkup and start				
	up				
HE-18	Troubleshooting the heating system				

INDIVIDUAL PROGRESS REPORT

NAME _____

PROGRAM Refrigeration, Heating, and Air Conditioning AREA Heating

UNIT NO.	UNIT TITLE	DATE STARTED	DATE COMP.	EST. TIME	GRADE
	OIL BURNING SYSTEMS				
HE-19	Identifying types of fuel oil and prin-				
	ciples of combustion				
HE-20	Designing and installing oil piping				
HE-21	Installing oil burners				
HE-22	Installing and servicing transformers				
	and electrodes				
HE-23	Installing oil pumps				
HE-24	Servicing blower, nozzle, motor and				
	coupling				
HE-25	Recognizing types of heat exchangers and				
	performing the combustion test				
HE-26	Installing controls				
HE-27	Performing pre-season start up and				
	checkup				
HE-28	Troubleshooting the oil burning heating				
	system				
HE-29	Installing and servicing humidifiers				

GROUP PROGRESS CHART

ELECTRICITY

PAGE 1

NAME	EL-01	EL-02	EL-03	EL-04	EL-05	EL-06	EL-07	EL-08	EL-09	EL-10	EL-11	EL-12	EL-13	EL-14	EL-15	EL-16	EL-17	EL-18	EL-19	EL-20	EL-21	EL-22	EL-23	EL-24	EL-25	EL-26	

GROUP PROGRESS CHART

ELECTRICITY

PAGE 2

69

NAME	EL-27	EL-28	EL-29	EL-30	EL-31	EL-32	EL-33									

GROUP PROGRESS CHART

REFRIGERATION

70

NAME	REF-01	REF-02	REF-03	REF-04	REF-05	REF-06	REF-07	REF-08	REF-09	REF-10	REF-11	REF-12	REF-13	REF-14	REF-15	REF-16	REF-17	REF-18	REF-19	REF-20	REF-21	REF-22	REF-23	REF-24	REF-25		

GROUP PROGRESS CHART

AIR CONDITIONING

PAGE 1

71

NAME	AC-01	AC-02	AC-03	AC-04	AC-05	AC-06	AC-07	AC-08	AC-09	AC-10	AC-11	AC-12	AC-13	AC-14	AC-15	AC-16	AC-17	AC-18	AC-19	AC-20	AC-21	AC-22	AC-23	AC-24	AC-25	AC-26	

GROUP PROGRESS CHART

AIR CONDITIONING

PAGE 2

72

NAME	AC-27	AC-28	AC-29	AC-30	AC-31	AC-32										

GROUP PROGRESS CHART

HEATING

PAGE 1

73

NAME	HE-01	HE-02	HE-03	HE-04	HE-05	HE-06	HE-07	HE-08	HE-09	HE-10	HE-11	HE-12	HE-13	HE-14	HE-15	HE-16	HE-17	HE-18	HE-19	HE-20	HE-21	HE-22	HE-23	HE-24	HE-25	HE-26

GROUP PROGRESS CHART

HEATING

PAGE 2

74

NAME	HE-27	HE-28	HE-29														

ORGANIZING THE LABORATORY

ORGANIZING THE REFRIGERATION, HEATING, AND AIR CONDITIONING LABORATORY

In order to successfully operate a refrigeration, heating, and air conditioning program, the laboratory must be organized in a manner which permits each segment of the program to function efficiently and with adequate space. It is suggested that each major block of the program exist as a separate entity within the program. This requires that each area have designated space within the laboratory; therefore, training activities may take place without interference from other areas. As students are rotated within the major blocks there should be little confusion about where specific training skills will be learned.

An important reason for maintaining a well organized laboratory is to insure that conditions are conducive to individually planned instruction. Adequate space in the laboratory should be designated for a Learning Resource Center (LRC) providing a quiet area for reading assignments and other activities which may require thought and concentration. The refrigeration, heating, and air conditioning program like other occupational training programs tends to be noisy at times. Therefore, it is desirable to locate the "study space" in an area near manipulative activities but isolated from noise and dust accumulation.

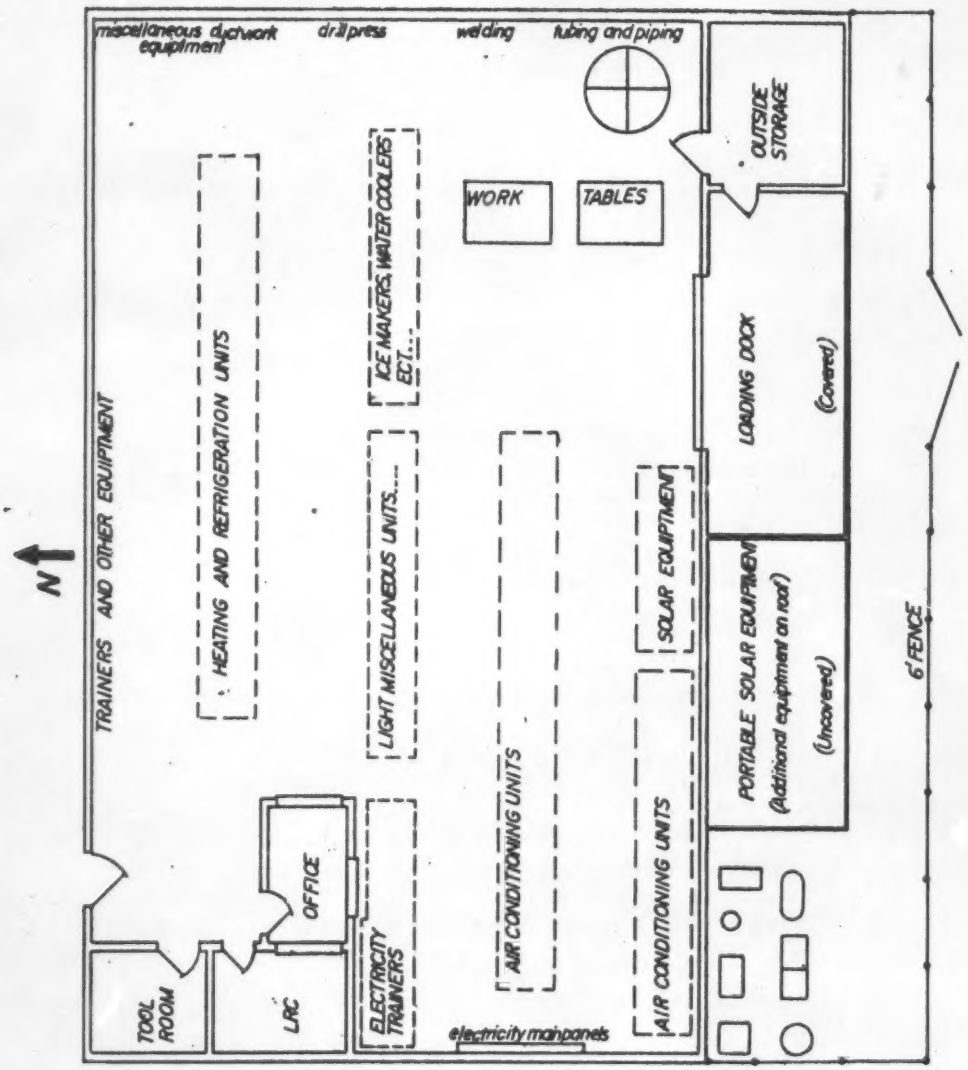
The enormous number of tasks and activities required to maintain a well developed program in the environment conditioning trades implies that much space is required. Unfortunately the laboratory is seldom large enough to facilitate all of the activities and training projects that are needed. Areas such as solar heating and central air conditioning usually require much space; for this reason a greater portion of laboratory space will be needed for these and other similar activities.

Proper consideration must be given when assigning space for these areas. In Figure A, observe one recommended layout for a refrigeration, heating, and air conditioning laboratory. This plan may not be the ideal layout because of the limited space (a common problem) in the laboratory. However, a systematic approach of this type in the layout and organization of the laboratory will lend itself to a more efficiently managed system of instruction. An invaluable activity recommended to the instructor is to make a scale drawing of the laboratory and locate the components of the program (in the form of paper cut-outs) in their most efficient setting. Regardless of whether space is limited or overabundant in the laboratory, efficient operation can be maintained through planning and organization.

Each piece of equipment in the laboratory requires adequate work space to insure safe conditions. Space is needed to move and transport various types of equipment and appliances within the laboratory without endangering students working on other projects. Another consideration concerns activities requiring the use of handtools and portable tools. Training projects requiring the use of these tools may be of varying magnitude. Space can be allocated by locating open or free space within the laboratory in each designated area. The free space will serve as working space where large training projects and activities associated with those areas can function.

Work tables, useful items of equipment in a shop, may be placed in key areas of the laboratory where they may be designated for small projects in specific areas. However, if work tables are not needed, it is useless to have them crowding useful space. Equipment and tables placed indiscriminately throughout the laboratory provides a deposit

Layout For Refrigeration, Heating, and Air Conditioning Laboratory



In the lab the one major recommendation can be made is to insure flexibility is preserved. For example, it is possible to build mock-up wiring boards on hinges and casters which can be folded and easily moved. In addition, trainers for refrigeration and electricity can be placed on locking wheels to provide even more flexibility. Even work tables can be made mobile which will allow the instructor much leeway to experiment with.

FIGURE A

area for unused scraps and materials from the various projects. Removal of unused or rarely used equipment and furniture will improve housekeeping conditions throughout the entire laboratory.

Planned safety lanes in the laboratory are essential elements in insuring proper organization and safe operation of the program. Careful planning should also precede locating the LRC, tool room, and storage areas. Important in the benefits received will be a decrease in student traffic from one training area to another. Organization and planning of the highest level, however, will not rid the program of some traffic through each of the areas. Therefore, it is important to work safety lanes carefully into the scheme of the laboratory design. This may be done by providing three or four feet for necessary student traffic throughout the laboratory. Locate safety lanes outside of areas designated as work space for specific equipment and avoid locating them near grinders or other stationary equipment where hazards may exist.

Listed below are items from the preceding discussion concerning the laboratory design. They may be used to form a checklist in designing the refrigeration, heating, and air conditioning laboratory in a safe and efficient manner. It is likely that many other helpful ideas may be utilized in the design, however, these are quite essential to maintaining a functional and free flowing program of instruction.

1. Learning Resource Center
2. Tool room

3. Stationary power tools

4. Work space for stationary power tools

5. Work tables (areas to use special handtools and some portable power tools). Be sure to include adequate work space.

6. Open or free space

7. Material storage

8. Safety lanes

B. Tool Room and Storage Areas

1. Sections of the Tool Room

a. Handtools can be arranged on a pegboard according to types--hammers, pliers, etc. It is important to avoid placing more tools on the peg board than could conceivably be used at one time. Additional tools should be stored in a locked cabinet until items on the pegboard need replacing. The tools selected for the pegboard should be outlined or silhouetted so that a quick visual inventory can be made. For ease in replacing tools, at the end of each class session place an identifying mark both on the tool and on the position it is located on the pegboard. This will enable the instructor to determine not only what type of tool is missing but which tool of a certain type has not been placed in its appropriate postion.

Large handtools may be handily placed on a pegboard. It is desirable, however, to use a separate wall or wall section for these tools.

b. Portable power tools should make up a section of the tool room. These may be simply laid on a shelf similar to bookshelves and with a little ingenuity can be neatly displayed into stenciled sections of plywood and shelving. The latter suggestion usually provides a more organized tool room.

c. Meters, gauges, testers, and other delicate instruments can easily make up a small section of the tool room. These may easily be placed on shelves or in cabinets, however, care should be taken to insure that such instruments are secured to avoid damage that may result from falling. Again, it is important to make available only the number of tools needed to avoid wasting valuable space.

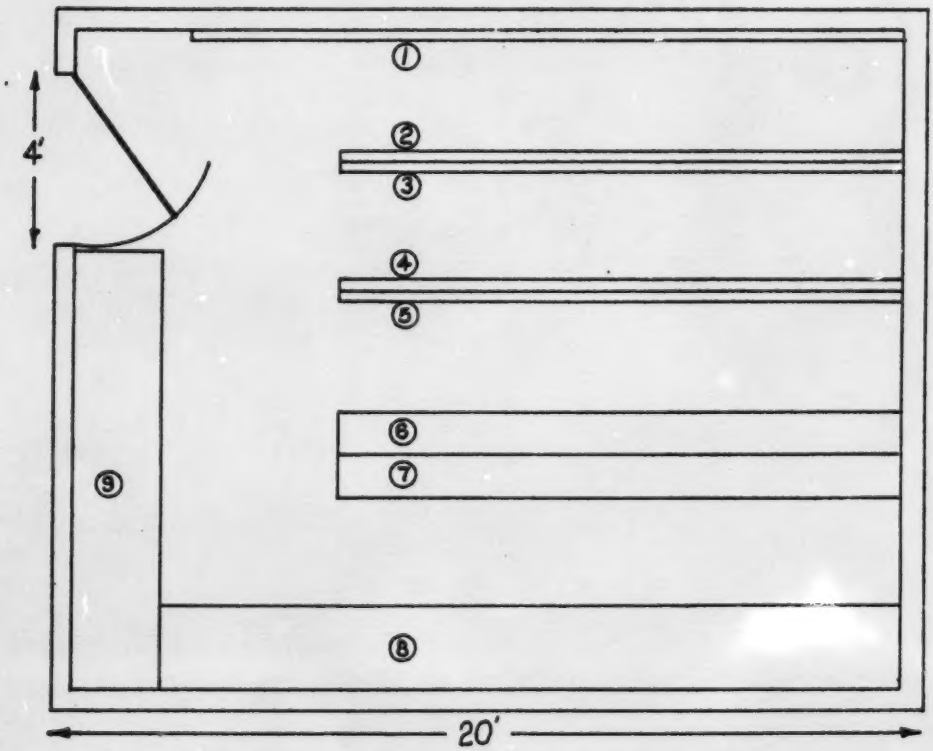
d. Special tools for sharpening, adjusting, maintaining, etc. equipment, may be stored together for easy access. These may be placed on a shelf or mounted on a pegboard.

e. Occasionally other training components used with activities of the refrigeration, heating, and air conditioning program can easily be stored on open shelves. It is important to be selective about the components housed within the tool room.

f. A valuable asset to the operation of the tool room is to provide a table top cabinet where tools may be cleaned, sharpened and repaired. This would probably be done by student helpers whose assignment is to check tools out to members of the class.

TOOL ROOM KEY

1. & 2. Pegboard for most frequently used hand tools (hammers, pliers, etc.)
3. Pegboard for large handtools (shovels, etc.).
4. Pegboard for special tools for sharpening, equipment maintenance, and equipment spare parts.
5. Pegboard for additional tools.
6. Shelf space or stenciled plywood for portable power tools.
7. Shelf space for meters, gauges, testers, etc.
8. Cabinet space (low) can store extra tools. Shelves (high) can store training components which are frequently used.
9. Table top cabinet space for use of tool room attendent for cleaning or repairing tools.

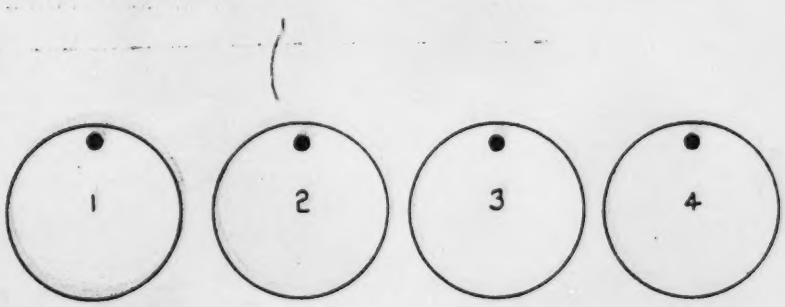


2. Tool Check System

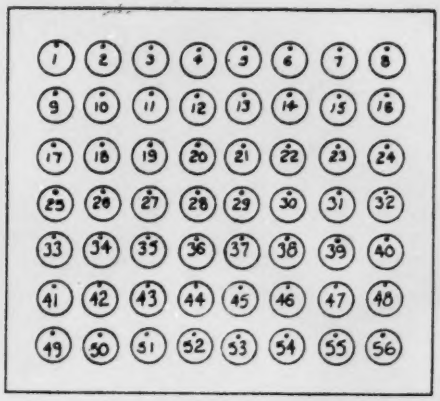
A. The tool room should be arranged so that a quick visual inventory may be made at the end of each class period. Each space and each tool occupying that space should be marked in the same way. This will insure that every item is returned to its exact position on the pegboard or shelf.

B. Tools and components checked out should always be recorded so that the instructor knows who has them. One of the quickest and neatest methods of doing this is to prepare metal tags on which numbers are stamped. Each student is assigned a number. When the student withdraws a tool or component from the tool room a numbered tag assigned to the student is left in its place. The tool room attendent has a board which contains all of the tags and simply moves them as items are checked in and out. Below is an example of how this can be done.

Metal tags are stamped with an identifying number and placed in the position of the tool until it is returned.



A tag panel can be positioned to hold the tags to insure that all tools have been returned. A missing tag on the board would determine which tool has not been returned and to whom it was issued.



C. Another tool check system utilizes a "Tool Request Form". A box containing the forms would be located outside of the tool room area. The form may contain information such as the name of the student, the tools requested, and the identifying numbers. The form should provide spaces for a maximum number of tools suggesting that only a maximum number of items can be checked out at any one time (usually about five tools are sufficient). When students fill out request forms they then exchange them for the needed tools. The tool room attendent would then issue the tools and place the request form in another box located inside the tool room. When the tool is returned the tool request form is merely discarded.

The following page can serve as a master copy for duplicating such forms if this system is of particular interest to the instructor.

TOOL REQUEST FORM

Name _____

ITEMS:

1. _____
2. _____
3. _____
4. _____
5. _____

TOOL REQUEST FORM

Name _____

ITEMS:

1. _____
2. _____
3. _____
4. _____
5. _____

TOOL REQUEST FORM

Name _____

ITEMS:

1. _____
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TOOL REQUEST FORM

Name _____

ITEMS:

1. _____
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TOOL REQUEST FORM

Name _____

ITEMS:

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TOOL REQUEST FORM

Name _____

ITEMS:

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TOOL REQUEST FORM

Name _____

ITEMS:

1. _____
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3. _____
4. _____
5. _____

TOOL REQUEST FORM

Name _____

ITEMS:

1. _____
2. _____
3. _____
4. _____
5. _____

C. Learning Resource Center-LRC

1. To function within an individually planned curriculum it is necessary that students participate in various types of activities. Many of these activities need areas which are acoustically isolated from the various manipulative and sometimes noisy activities of the electro-mechanical laboratory. For this reason it is desirable to maintain a Learning Resource Center where some or all of the following activities can function undisturbed:

   Reading

   Studying

   Answering questions

   Looking and listening to audio-visuals

   Using references

   Doing research

   Discussing ideas

   Thinking over problems

   Taking tests

   The instructor needs a place where ideas, problems, and solutions can be discussed with one or more students without being visually separated from the rest of the class. The distinctive nature of a planned curriculum requires that students sometimes work as individuals, in small groups of two or three, and occasionally in large groups conducted by the instructor. The LRC provides an isolated area where these groups can meet away from the noise and distractions of the refrigeration, heating, and air conditioning laboratory.

2. The tendency to use the LRC as a storage area should be avoided. The only storage function to be served by the

LRC should be for items and materials which facilitate the learning activities mentioned earlier in this section. Following is a list of items which serve a definite purpose in the center to facilitate learning:

Textbooks

References

Service Manuals

Trade Journals

Audio-visuals

Audio-visual Equipment

Student Manuals

Repair Manuals

Student Files

"Master Copy" of the Student Manual

3. The refrigeration, heating and air conditioning curriculum contains approximately seventy-five to eighty-five percent hands-on instructional activities. Usually three or four learning carrels with audio-visual capabilities will meet the needs of the curriculum. Approximately two or three feet of usable space, other than that occupied by AV equipment, is also needed for students to take notes or to perform the various activities suggested by the slide presentation.
4. There should be one study station for every three students and an area available large enough to accommodate approximately 1/3 of the students. When space is not available the individual study stations should be moveable. The stations may be arranged according to need, to accommodate individuals or small groups. In either case avoid arranging the seating as if preparing for a traditional lecture group setting.

5. The program will need a minimum of the following audio-visual hardware:

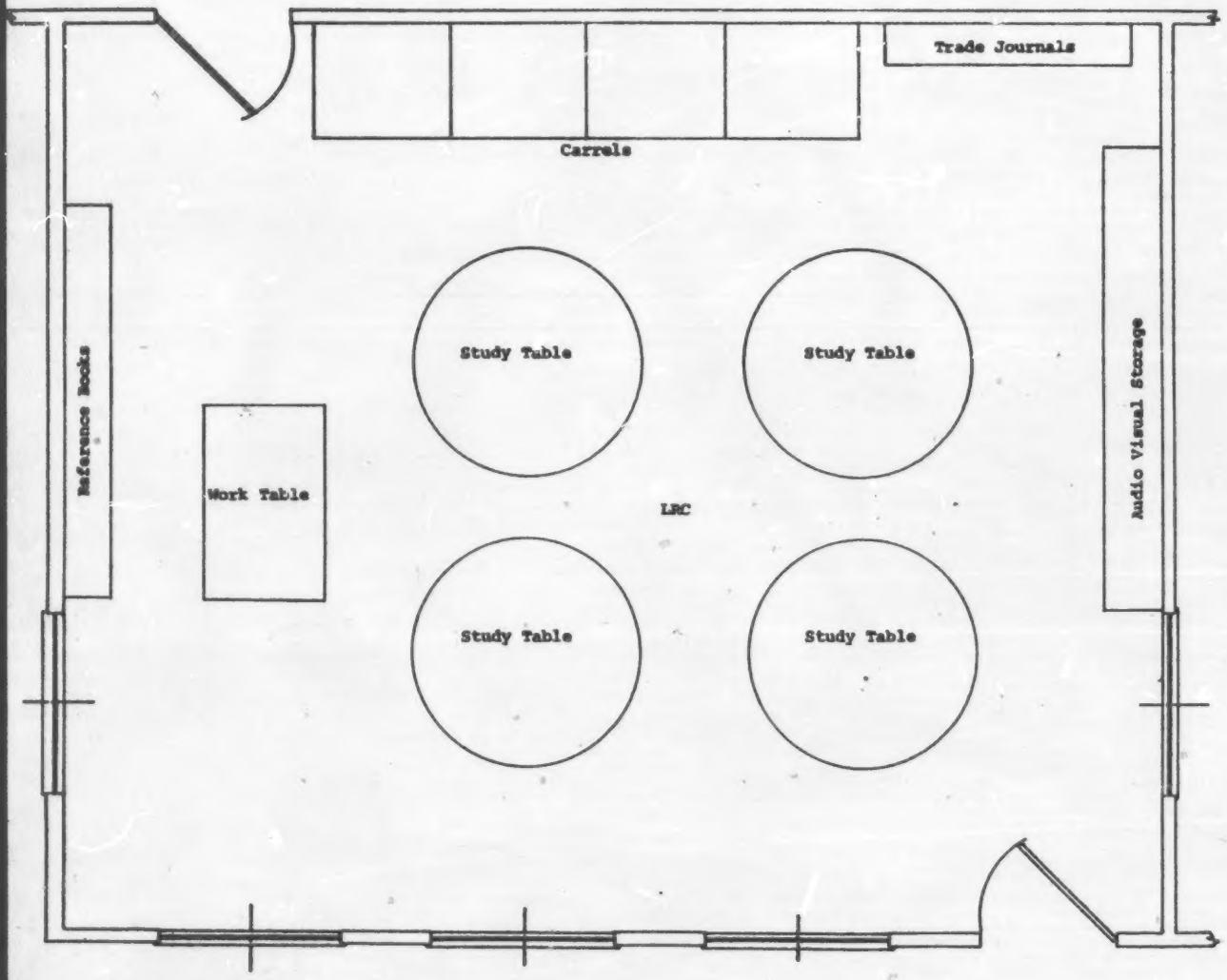
Description	Number Required
Singer Caramate Playback, Model 8805	2-3
Listening Center with at least 4 headset outlets	2-3
Magnetic headset (overhead type) with washable vinyl ear cushions	6
Shelf storage for carousel trays (for approximately 110 slide boxes) if each slide set is placed in a separate box. If more than one presentation is placed in each box fewer trays will be needed.	1
Cassette storage cabinet (for approximately 110 cassettes)	1

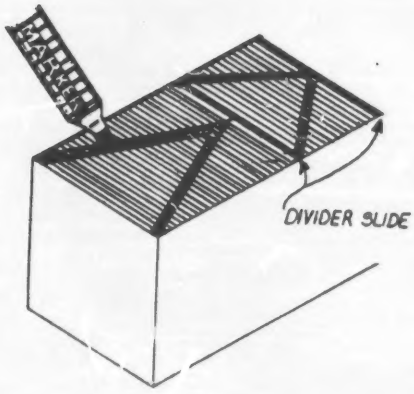
To avoid down-time with the audio-visual equipment keep a few spare bulbs on hand. This will help to prevent gaps in the flow of the various instructional activities.

6. Storage of audio-visuals is an important factor in the smooth operation of the program. Slide trays and tapes should be identified with a code which keys them back to the learning packages. They should also be identified with a sequencing number denoting the position on the shelf or cabinet. This will insure that materials are returned to their proper location and can easily be found by the next student who needs the materials.

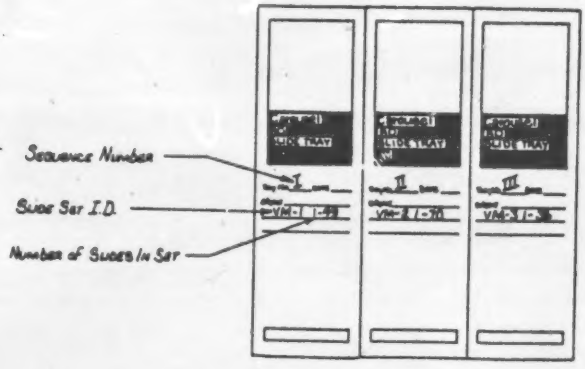
Slides will be received in boxes containing approximately 125 slides. There will be as many as three or four slide presentations to each box with a marked slide or rubber band separating the different sets. Use a felt marker pen to draw a large V on each set in the box. This is a safeguard in the event that a set is spilled before being placed into the slide trays. Reassembly may be achieved by reconstructing the V.

LEARNING RESOURCE CENTER





The accumulation of dust in the laboratory indicates a need to store slide trays inside boxes. Slide boxes usually store easily on book shelves where the boxes and their position on the shelf can be identified for easy replacement.



Tapes should be numbered in the same fashion as the slide trays and boxes. Place a number on the cassette cartridge and the ID card in the plastic sleeve. To prevent accidental removal of the ID card, remove the perforated tab on the edges of the card. Several commercial tape storage cabinets are on the market which offer well organized systems for storage. One method which keeps tapes handy

and organized comes in the form on an index card file cabinet which has been sectioned for tapes. The card file cabinet is easily adapted and the drawers can be designated by appropriate areas.

A "homemade" storage cabinet such as Figure B may prove useful if expenses are such that commercial storage cabinets cannot be purchased.

D. Reviewing Materials

1. To insure the proper operation of the program it is essential that all of the REACH curriculum materials be reviewed by the instructor. A thorough understanding of the techniques involved in the use of the materials can be determined by studying information presented in the teacher's guide. Many suggestions are offered which may simplify some otherwise difficult processes.

   Good instructors will initiate numerous original ideas from their wide range of experiences. It is usually beneficial, however, to view common problems from a slightly different perspective. A thorough review of the curriculum materials should stimulate ideas contributing to the smooth operation of the instructional program.

2. Student manuals from the REACH materials are complete and require few corrections except for changes relating to individual program needs. Review of the manuals, however, can insure that the instructor is informed of the activities to be performed by students. It may be necessary for special set-ups or mock displays to be assembled before students reach various stages of the instruction. A thorough review of the materials will aid the instructor in avoiding certain "surprises" which occur as a result of activities called for in the student instruction.

"HOMEMADE" STORAGE CABINET

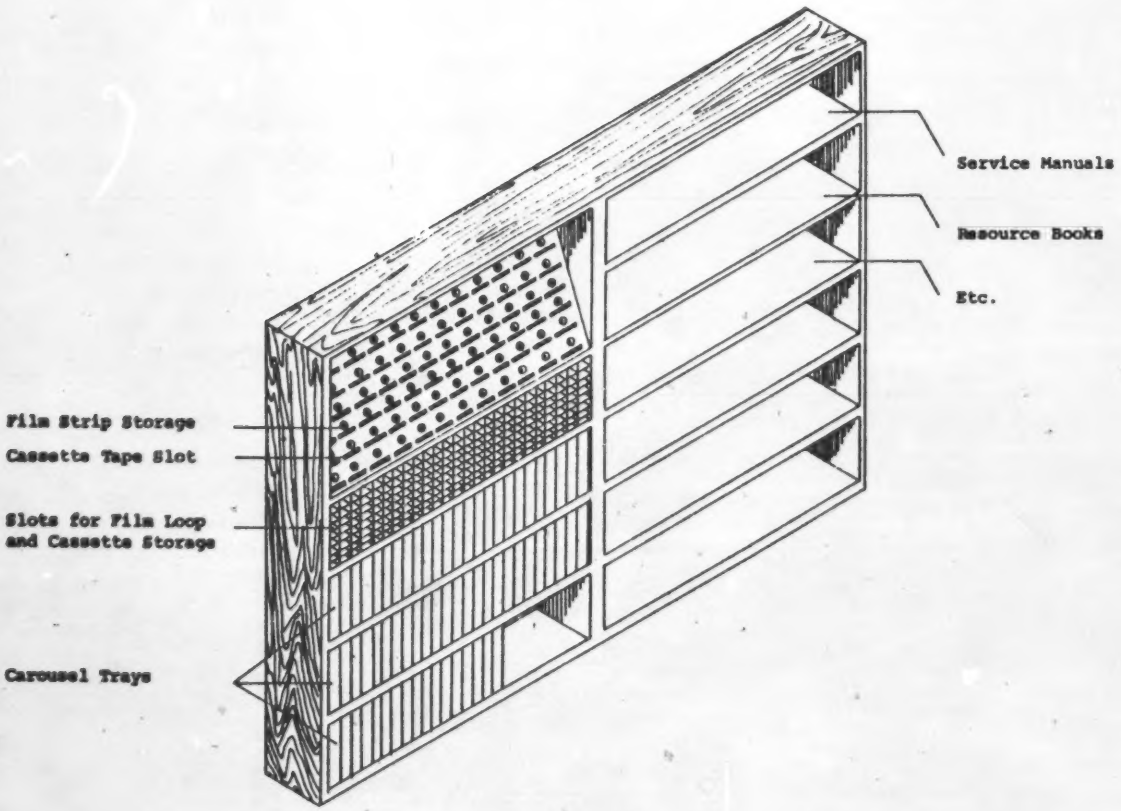


FIGURE B

3. Develop a test situation which covers all vital activities.
   Make sure that the performance test will cover everything the student is expected to know. Take care not to leave out important (critical) steps.

4. List all tools, materials and equipment.
   Tell the student being tested exactly what is needed to perform the test.

5. Give directions.
   Complete written (or in some cases oral) directions should be given to the student. These should be revised if any confusion is indicated.

6. Prepare scoring criteria.
   Sometimes a test is a yes/no situation, in other cases a percentage correct scoring situation is appropriate. Whatever the objective calls for should be used as the scoring criteria.

7. Review and evaluate the test.
   The teacher should make sure the test is not so lengthy that it cannot be given under normal circumstances. Also, any quirks or rough spots on the test may be smoothed out at this point.

Developing Affective Measures

Educational experts generally agree that attitude measurement is one of the most difficult types of measurement. Educators and others in the behavioral sciences have had only limited success measuring student attitudes.

Rating Scales and Checklists can help guide the instructor in measuring student attitudes. In using these observational devices the teacher must subjectively rate the student's development in the affective domain toward course objectives. Teacher judgement and teacher observation are used to systematically categorize the particular behavior under consideration. Construction of attitude rating scales and checklists is very similar to previously discussed methods.

An important point to remember when making subjective attitude judgements is the criterion upon which the judgement is made. For the instructor to say to the student "your attitude is bad" is not appropriate. The student must be made aware of the acceptable behaviors and only compared to these.

Other methods which may be used by the instructor to assess affective behavior are essays, case studies (problem solving), structured interviews, unstructured interviews and oral examinations.

The audio-visual materials which accompany the REACH curriculum are generally in good condition. Problems which arise usually occur in the packing, shipping, and unpacking of slides. A quick review of slide presentations will determine if slides are out of sequence. As a solution when problems occur, the REACH curriculum contains as Teacher's Guide Volume V scripts which can be used to return slides to their position in the slide presentation.

For ease in changing text assignments and references resulting from out of date textbooks the curriculum utilizes a "Text Assignment Sheet" (Figure C). Materials do not refer students to a specific book for their assigned reading; instead they are referred to the text assignment number which is usually coded the same as specific packages used in the instructional materials.

The "Text Assignment Sheet" will be part of the student manual and is also located in the teacher's guide (the next major section). Assignments can be changed by removing the existing assignment and by designating the new materials or resources to be used. Requiring students to make the changes themselves will relieve the instructor from the time consuming burden of changing all of the student manuals.

As can be easily seen on the "Text Assignment Sheet" references and resources are referred to by textbook numbers. Books and references should be assigned numbers which should permanently identify them throughout the instructional program. Whenever textbooks have gone out of print and are not longer available for purchase, another text can be easily substituted. When numbers have been assigned, textbooks should be labeled and placed on the shelf for easy reference.

To accomodate as many as three or four students who reach a given level of instruction, it is desirable to have at least five textbooks of each type--each would be labeled with the same textbook number.

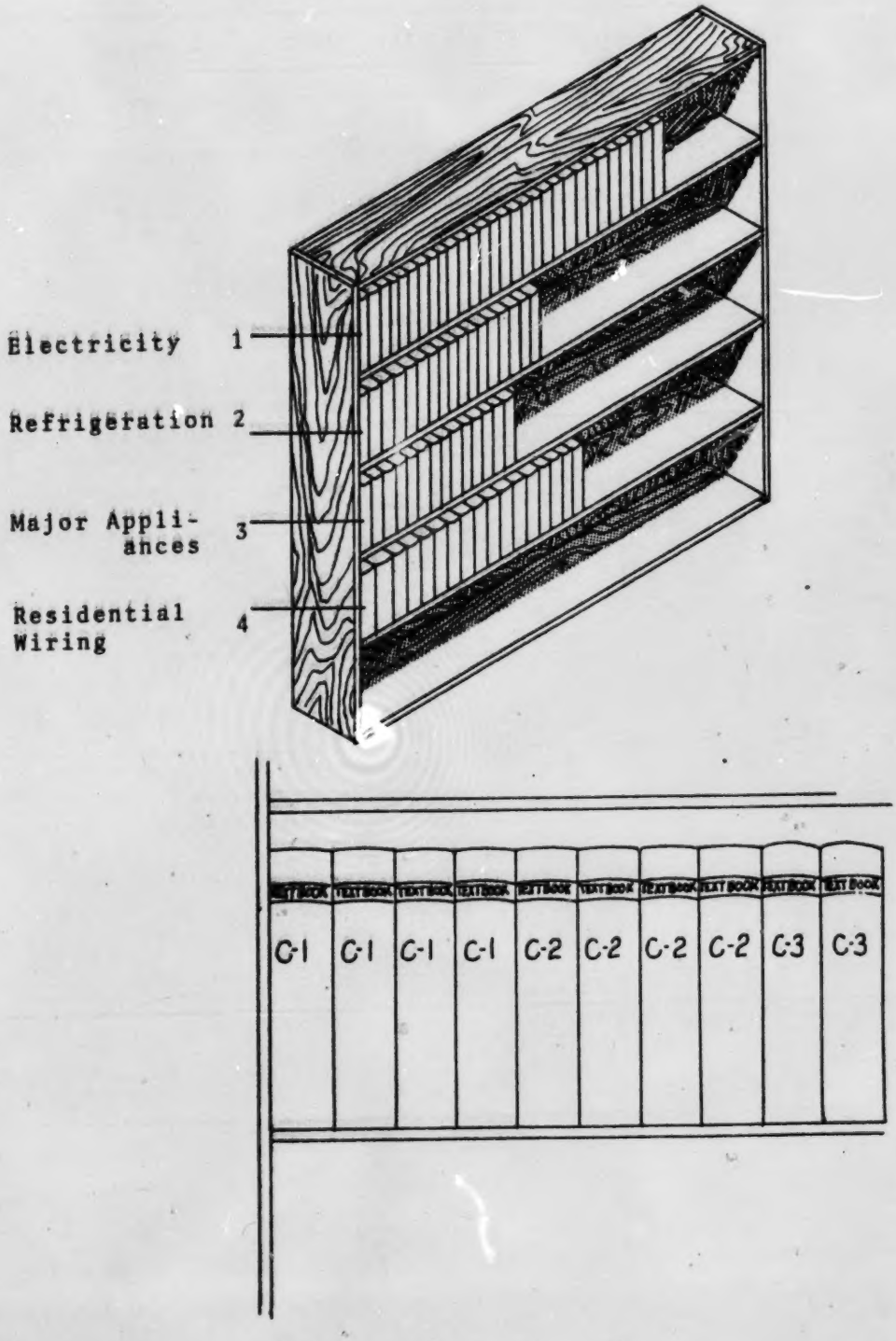
Student manuals may also be stored in the LRC. To insure neat organization and management of the area it may be desirable to separate them according to class and trade area.

RESOURCE AND TEXT ASSIGNMENT SHEET

ASSIGNMENT NO.	TEXT NO.	PAGES	STUDY ASSIGNMENT
Blueprint Reading			
BR-1	1	63-67	
BR-2	1	10-14	
BR-3	1	24-30	
BR-4	1	43-52	Use the chart on page 45 to identify the building parts and materials on information sheet BR-4.
BR-5	1	31-42	
BR-6	1	67-76	
BR-7	1	77-88	Complete the "Self Check Quiz No. 7" on page 85.
BR-8	1	89-102	Complete the "Trades Competency Test No. 7" on pages 101-102.
BR-9	1	103-108	Complete the "Self Check Quiz No. 9" on page 100.
Post Check BR 1-9	1	Inside back cover	Use the set of blueprints called "Ponderosa Pine Woodwork" to complete the post check.

FIGURE C

BOOKSHELF WITH CODED TEXTBOOKS



TEXTBOOK LIST

Text Number	Title
1.	Refrigeration and Air Conditioning. (Air Conditioning and Refrigeration Institute 1815 North Fort Meyer Drive Arlington, VA 22209) Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632, 1979.
2.	Modern Refrigeration and Air Conditioning. Althouse, A.D., Turnquist, C.H. and Bracciano, A.F. The Goodheart-Willcox Company, Inc., South Holland, Illinois, 1975.
3.	Electricity for Refrigeration, Heating and Air Conditioning. Smith, R.E. Duxbury Press, North Scituate, Mass. (Div. of Wadsworth Publishing Co., Inc., Belmont, Calif. 94002, 1978.
4.	Oil Burners (2nd ed.) Field, E.M. Howard W. Sams Co., Inc., Indianapolis, Indiana 46206, 1974.
5.	Domestic and Commercial Oil Burners: installation and servicing. Burkhardt, C.H., McGraw-Hill, Inc. New York, N.Y., 1969.
6.	Doolin's Trouble Shooters Bible. Doolin, J.H., Doolco, Inc. Technical Publications, 2016 Canton Street, Dallas, Texas, 1963.

MANAGING THE PROGRAM

MANAGING THE PROGRAM

Starting Students

The grading period or other regularly scheduled breaks within the academic year may imply a termination point in a course of instruction. This traditionally provides the point in the program at which students rotate from one area of the program to another. Unresolvably, the grading period differs somewhat between schools, therefore, making the designation of specific number of objectives for each course somewhat impractical in this teacher's guide. However, objectives in the curriculum are grouped according to major blocks and performance groups (minor blocks) and assigned to their proper positions in the instructional sequence. It is the teacher's responsibility to determine how many objectives must be completed in a given grading period and the amount of time that students have to master each objective.

Starting twenty students at one time in a single area would place an unnecessary burden on audio-visuals, textbooks, and other resources which enable the instructional area to function. Therefore, it is desirable to group students according to instructional area. Basic skills which require little prerequisite training must be mastered in each area of the program. This identifies several logical starting points from which groups of students may begin their training.

When a program has been operational for as long as a year, the veteran students will not be competing for the same instructional materials and supplies as beginning students. Their activities require more specialized training, more in-depth knowledge of the subject area and require that they use a variety of skills already mastered to accomplish further advanced tasks. These students will also form groups but will have a greater spread among the many objectives than do those in the first year. This is expected because students

have started to make selections related to their desired career choices. Quite naturally, a few students will decide after a few months that they do not really have an interest in any of the electrical occupations and will leave the program. This again will ease the demand for space and materials for each trade area and will make space available for other new students.

Operating the Program

The planned instruction units of the curriculum direct the learning of students in the various areas of the program. There comes a point in the procedure, however, where instructor input is necessary to insure activities are completed in the proper sequence, according to set standards, and to insure that safety practices and precautions are maintained. This valuable instructor input is controlled through the use of the second volume of the teacher's guide, "Check Points".

At various points throughout the instructional process and programmed into the individually planned materials, the student is instructed to report to the instructor. Instructor checks are placed within the learning sequence which are coded back to the "Check Points" volume of the teacher's guide. When the student is directed to the instructor, the check points will clarify what should be done by the instructor. The student may be at a critical point in the procedure which requires professional observation to insure that a vital step in the operation is performed accurately to maintain safe conditions for the user of the product. The check points, if used correctly, will insure that students do not miss valuable steps in the learning sequence.

Each unit of the check points volume of the teacher's guide contains a section entitled "General Comments". This section offers some valuable hints in the set-up and evaluation of specific student objectives. Remarks concerning the type of activity and a description of the project on which the task should be performed are offered to ease the painstaking instructor tasks of producing meaningful training projects for student learning.

UNIT NO. HE-02

OBJECTIVE:

Install an electric furnace using manufacturer's installation instructions and wiring charts.

GENERAL COMMENTS:

An electric furnace complete with manufacturer's installation instructions, wiring and thermostat is needed.

CHECK POINTS:

C-1 Check Assignment Sheet HE-02a

(A) Most electric furnaces may be positioned in any way except one which would have the fan cage hanging on the blower bearings.

(B) Most electric furnaces require from 0" to 3" clearance on all sides.

(C) A straight heat thermostat with an electric heat subbase is used.

(D) Most furnaces may not be wired with aluminum wire. Some manufacturers will void warranty.

Wire sizing charts are usually provided. However, if not, simply refer to the N.E.C.

C-2 Check installation clearances, thermostat location, and wiring for correct size and type.

Another valuable tool for use in operating the electro-mechanical program is a "Set-up Description" developed by the instructor as the units are reviewed in preparation for student use. This is a condensed version of the types of training activities and projects to be performed by students. Instructors may use this list to collect materials, build training modules, and assemble mockups for student use prior to student entry into that block of instruction.

Keep in mind that these are only suggestions. Experienced instructors may prefer different activities or projects which they feel teach the task more accurately. If this is the case, those activities can be collected for each learning unit and inserted into the set-up description. The list can be formulated by briefly checking the "General Comments" section of the "Check Points" volume of the teacher's guide.

Use of Training and Live Projects

The ultimate purpose of the program is to place students into jobs related to the environment conditioning industry. For this reason it is important to keep the laboratory environment as closely associated with that of the occupational setting as possible. The isolated nature of the school laboratory, however, causes various problems in maintaining such an environment. It is the responsibility of the instructor to make the laboratory a place where tasks and activities are taught in an environment which is closely related to the "real" world.

Live work continues to be viewed as a valuable asset to any instructional program. It is usually the only way which training projects can produce a return on invested expenses and is essential for the development of well trained students. At least a minimum amount of live work should be interfaced with the instructional program; otherwise, the student may not realize the value of producing a quality product and accepting responsibility for pleasing the customer. Participation in live work may also permit the student to visualize the actual conditions which exist on the job, since those conditions may be difficult to simulate inside the laboratory.

The value of live work in the program cannot be overemphasized, however, the availability of live work is not always convenient when students reach

specific objectives in their prescribed sequence. If live work can be utilized when it is needed it will, by all means, be a vital link in student development. Live work must not dictate the activities which exist in the instructional program. When this happens instructional objectives become meaningless and the far reaching goals of the program begin to float into uncontrollable chaos.

EVALUATION

EVALUATION OF STUDENT PROGRESS

Each area within the curriculum has a wide range of skills which must be mastered before each unit of instruction has been completed. A reliable assessment procedure is therefore necessary to determine the student's proficiency level as the student completes a unit. Assessment is also important in identifying the student's knowledge and skill developmental weaknesses. Identification of these weaknesses will permit the instructor to diagnose and prescribe alternative methods of instruction. The concept of criterion-referenced testing is tailor-made to accomplish this purpose.

Criterion-referenced test items which appear in Volume IV of this Teacher's Guide are directly related to the stated performance objective. They are designed to measure accomplishment of an exact objective and to measure the exact behavior required to accomplish a particular task. Criterion-referenced tests can and should be prepared to measure the mastery of both cognitive and performance skills.

Teachers should note, however, that the tests contained in the REACH materials will serve only as a beginning point. They are not comprehensive in nature and were designed to supplement teacher made examinations.

Relative to test preparation, two suggestions may be made. First, the teacher should begin developing test items as soon as is practical. These items may be recorded on index cards and filed by units. When testing is necessary they may be retrieved as needed.

A second suggestion concerning testing is an item pool exchange on an informal basis. Teachers from nearby schools may find it very helpful to exchange test items. Even if the test items do not prove to be "up to standard" they may be utilized as thought stimulators for more adequate items.

The test item pool should have the ability to examine both cognitive and psychomotor skills. It will contain multiple choice questions and answers for the cognitive areas and manipulative (hands-on) test situations for the psychomotor areas. In addition, observational devices may be developed (and shared) to evaluate skill performance for the manipulative tests.

Developing Cognitive Measures

In developing cognitive measures--multiple choice, open ended, short answer, and matching items should be used. True-False have no place in a vocational learning package. Overall, the multiple choice item is the best prospect for measuring cognitive ability. It utilizes the following components:

The stem: (the stimulus)

A- distractor
B- correct answer
C- distractor
D- distractor

} The Possible Responses

An advantage of the multiple choice question over other types of questions is its ability to be leveled according to Bloom's Taxonomy. This taxonomy (lists of categories) allows the teacher to determine the student's level of mastery from simple knowledge to the most complex levels of analysis and evaluation. A further advantage is the ease with which these items can be validated.

The teacher can use the taxonomy to evaluate the student's mastery level by carefully wording the test items which measure the six levels of learning in the cognitive domain:

1. Knowledge
2. Comprehensive
3. Application
4. Analysis
5. Synthesis
6. Evaluation

The Professional Teacher Education Module Series developed by The Center for Vocational Education at Ohio State University and published by AAVIM at the University of Georgia suggests five basic characteristics that a good test should have:

1. Validity -- The test should always measure what it is supposed to measure. Several important points come to surface when talking about validity of cognitive tests.

   -the test should measure knowledge of the subject matter only

   -tests should be reviewed by others in the field to determine validity of content

   -tests should relate precisely to the learning objectives

2. Reliability -- The test should always measure the student's learning with consistent results. The degree of reliability of a test directly sets a limit to the degree of validity possible. If a test of electrical knowledge is not reliable, validity is severely hampered. On the other hand, if the test of electrical knowledge has excellent validity, then it must also be reliable. Points concerning reliability

to be aware of are:

- test length
- test directions
- scoring procedures
- test readability
- the mental "set" of the students

3. Objectivity-- Simply stated objectivity refers to the fairness of the test. The vocational instructor must be acutely aware of how easy it is to be unfair in grading procedures. The teacher should be meticulously accurate with directions and the wording of test questions and again, the tests should relate directly to the learning objectives (especially when the objectives state criteria).
4. Discrimination -- The test should allow the teacher to discriminate (without bias) between a student who can perform satisfactorily on a test and one who cannot.
5. Comprehensiveness -- The concept of comprehensiveness goes beyond testing to see if a student has met an objective. The teacher must take a look at the entire section of the course the test is designed to cover. The test should relate to the stated objectives and the content of the section of the course being examined. When a match is not found new objectives and/or content must be established or the test must be revised.

Developing Psychomotor Measures

Both the cognitive and affective domains generally require measurements of "internal thought processes". However since the psychomotor domain

deals primarily with manipulative or "hands on" skills, it tends to be somewhat easier to work with.

For evaluation of the psychomotor or "hands on skills", the electro-mechanical teacher must rely on some sort of observational device. The device should allow for both self evaluation and instructor evaluation and should measure the objective criteria.

Dr. Aleene Cross, of the University of Georgia, in her text on student evaluation has described three such observational devices, they are: (1) checklists, (2) score cards, and (3) rating scales. The instructor will find that the use of such devices not only provides motivation for the student but also is an excellent source of documented competence for interested parents and future employers.

The observational devices should be constructed in the field by the teacher for the vocational subject areas. The format used can vary according to the needs of the course. The format samples shown on the following pages were developed by Dr. Cross and then modified to fit this particular program.

Three general rules for making up an observational device should always be followed; they are, (1) state the objective, (2) provide clear directions, and (3) be sure the device measures objective criteria.

Development of the observational devices is fairly easy for the instructor; and, student input in determining statements or questions will help keep them involved.

Steps leading to the development of the devices are as follows:

(1) Draw up a format such as shown in the following examples:
(2) State the objective.
(3) Write clear directions.
(4) Determine what statements or questions enable measurement of objective attainment.
(5) Determine point values and grading scales.
(6) Try out the device and revise if necessary.

The checklist is used to encourage the student to exhibit craftsmanlike skills. It is difficult to expect a student to know if the work completed conforms to industry standards without feedback from the instructor. Note that the checklist is not used for giving a grade. It's real value is to offer communication between the learner and the instructor. The exercise can be repeated as often as deemed necessary to reach an acceptable standard. The student performs this self evaluation prior to the instructor evaluation. Deviations between the student's score and the instructor's score should be discussed.

CHECKLIST FOR SOFT SOLDERING COPPER TUBING (REF-09)

OBJECTIVE: To swage, clean , flux and soft solder copper tubing using 50-50 and 95-5 solders.

DIRECTIONS: Place an (X) in the column that best describes the quality of your work. Ask the instructor to do the same.

	Student Check			Instructor Check		
	Poor	Average	Excellent	Poor	Average	Excellent
1. Handled torch in a safe manner.						
2. Cleaned torch correctly.						
3. Soldered with correct heat.						
4. Used the correct solder.						
5. Swaged fitting conforms to specifications.						
6. Quality of soldered connection.						
7. Orderliness of work area.						

Score cards are particularly useful in evaluating products and processes. Construction of score cards is relatively easy. Study the learning package and list those areas that are essential for objective achievement and assign standard and minimum scores that must be met. These scores may be used for grading.

Score Card for Soft Soldering Copper Tubing (REF-09)

Objective: To swage, clean, flux and soft solder copper tubing using 50-50 and 95-5 solders.

Directions: Score yourself from 1 to the highest possible score. Ask the instructor to do the same. You must achieve the minimum score for each criteria for successful mastery of the objective.

Objective Criteria	Std Score	Min. Score	My Score	Instructor's Score
1. Able to handle the soldering torches in a safe manner.	10	8		
2. Able to clean the soldering torch correctly.	10	8		
3. Able to light the soldering torch correctly.	10	8		
4. Know the types of solders and mixtures.	10	10		
5. Swaged fitting conforms to standards	10	8		
6. Soldering connection is properly prepared.	10	8		
7. Soldering connection is leak proof.	10	10		
8. Work area is clean and tools are returned to proper place.	10	8		
TOTAL SCORES	80	68		

A rating scale consists of descriptors indicating performance at various levels, usually from poor through excellent. Care must be taken in writing the descriptions to insure a clear continuum. The rating scale should be pilot tested to locate any errors or problems that may exist. These scores may also be used for grading.

RATING SCALE FOR SOFT SOLDERING COPPER TUBING (REF-09)

OBJECTIVE: To swage, clean, flux and soft solder copper tubing using 50-50 and 95-5 solders.

DIRECTIONS: Place the rating you select in the last column on the right under "My Score." If the rating falls between 1 and 2, it will be evaluated as poor, 3 and 4 will be average, and 5 will be excellent. Use a number for the rating.

1	2	3	4	5	MY SCORE	INSTRUCTOR'S SCORE
1. Soldering torch is not clean.		Torch is clean but not service-able.		Torch is clean and ready for next job.		
2. Unable to light torch.		Torch is lit but flame is improper.		Torch flame is adjusted correctly.		
3. Swaged fitting is improperly fitted.		Swaged fitting looks good but does not meet standards.		Swaged fitting is tight and meets standards.		
4. Soldering connection is dirty.		Connection is improperly cleaned.		Connection is bright and shiny.		
5. Connection leaks.		Connection will probably leak in the future.		Well soldered connection.		
6. Work area left messy.		Partially cleaned up.		Well organized, clean area.		
				TOTAL SCORES		

The instructor should realize that fair assessment of the student is a teachers responsibility. Arbitrarily assigning grades can cause serious complications in the growth of the program and the students. Checklists, score cards and rating scales provide the instructor with a fair method of observing and grading each student's product or process. This observation can be after-the-fact or can occur during the actual performance of the task, whichever is most appropriate.

The test of actual performance requires the student to accomplish an objective or perform a task under simulated job conditions. A test such as this should be standard for each student. The teacher will be able to tell from this test whether or not the student can actually accomplish the task--performing the correct procedures, in the correct order, and with proper safety precautions. A big disadvantage to this type of testing is the amount of observation time it requires. Therefore, some consideration should be given to "peer-testing", a situation where a senior or upper level student proficient in the skill being tested is given the responsibility of observing the student being tested.

An after-the-fact or product evaluation test can provide the teacher with much of the same information that a performance test can. This test, however, shows the teacher only the final product. The procedure or process is not evaluated. The advantage of this type of test is that it frees the teacher to work with other students. The products produced for the test can also be evaluated after school or at other convenient times.

The Heart of Instruction series prepared by the Ohio Agricultural Education--Curriculum Materials Service lists the following steps in preparing a performance test.

1. Relate the test to the objective.
   This practice will insure the test situation or problem is adequate to test a particular skill.
2. Develop a list of test operations.
   The teacher should analyze the tests activities and put in writing the standards expected.